FLOOD CONTROL, MISSISSIPPI RIVER & TRIBUTARIES

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

US Army Corps Of Engineers
Vicksburg, Memphis and New Orleans Districts

CAPE GIRARDEAU, MISSOURI TO HEAD OF PASSES, LA

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VOLUME III:

APPENDICES 7-17

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

SUPPLEMENT NO. 1 TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT MISSISSIPPI RIVER AND TRIBUTARIES PROJECT MISSISSIPPI RIVER LEVEES AND CHANNEL IMPROVEMENT

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MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
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APPENDIX 7
SOCIOECONOMIC ANALYSIS

SECTION 1 - INTRODUCTION

STUDY OBJECTIVE

1. The objective of this analysis is to provide an understanding of the potential impacts of the main stem levee of the Mississippi River and Tributaries Project on the surrounding region. This study utilizes an updated objective analysis of relevant past and present economic conditions to develop a baseline for determining the future direction of the affected areas in terms of demographic and economic growth. It includes project impacts to the areas affected in three U.S. Army Corps of Engineer Districts--Vicksburg (CEMVK), Memphis (CEMVM), and New Orleans (CEMVN). The economic analysis is only one segment of a Supplemental Environmental Impact Statement prepared in response to concerns surfaced by various environmental groups.

2. The primary purpose of this appendix is to show the significance of the project on the socioeconomic environment in the area adjacent to the Mississippi River main stem levee. It is part of a comprehensive study concerned with identifying problems, determining needs, formulating alternative water resource improvement plans, and evaluating such plans in accordance with environmental quality and social well-being.

3. In the comprehensive planning process, a consistent data base of socioeconomic growth and development parameters is needed to understand the socioeconomic environment of the region. This understanding is utilized to describe potential impacts to the region arising from proposed water resource projects. In describing these impacts, economic and demographic data for the following characteristics were among the parameters evaluated for their historical significance to the economic base area--population, labor force, employment, earnings, income, farm characteristics, industry, business and finance. Expected future conditions are expressed by projections of population, employment, and income. Data presented herein furnish an analysis of the past, present, and projected future economic development based on historical growth patterns and expected future conditions. The Mississippi River main stem levee will be referred to as MRL in the report.

4. All data in this section, unless otherwise noted, were obtained from the Bureau of Census for the year presented with the County and City Data Book as the primary source. Information from this source is derived primarily from Census data. This allows for consistency in data sets which is necessary for evaluation of changes that have occurred over the period of analysis. All monetary values are presented in constant 1996 dollars. Most of the statistics for the Memphis District study area were obtained from the document, "Mississippi River and Tributaries Project, Mississippi Main Line Levee, Supplemental Socioeconomic Base Study," prepared by Gulf Engineers and Consultants, September 1997. Projection factors were derived from projections prepared by the Bureau of Economic Analysis for each state in the MRL economic base study area. These factors were then applied to each District study area to develop future estimates of population, employment, and income. Projections should not be interpreted as being precise values for future years. Rather, they should be used as indicators of the direction and relative magnitude of economic activity that may be expected over the 50-year growth period.

SECTION 2 - OVERVIEW: MR&T PROJECT, MISSISSIPPI RIVER MAINLINE LEVEE

5. A comprehensive overview of the overall area affected physically or economically by the Mississippi River main stem levee project is presented in the following section. This synopsis includes a description of the economic base area and its historical significance to the general region; a background of the MRL project; and a discussion of other Mississippi River improvements and accomplishments. A special emphasis is given to significant impacts relevant to project implementation. This includes a discussion of project effects regarding the economy, flood damages prevented by the project, and other related impacts or contributions from the project.

BACKGROUND

6. The MRL project is vital to the overall flood control system of the Mississippi River. Because of its low-lying valleys, flooding on the lower Mississippi River threatens crops and cities along its banks. Because of this, measures of flood control improvement have been considered in this region since the earliest records of flooding in the 1800's.

7. The Mississippi River and Tributaries Mainline Levees Project, which has been under construction since it was authorized by the Flood Control Act of 1928, consists of four primary elements of improvement--levee enlargement, underseepage control, stability berms, and erosion control. The project, which was amended to correct deficiencies identified following the 1973 Mississippi River flood, requires that 263 miles of mainline levee be raised to protect the Mississippi River alluvial valley from the 1973 project level flood. Upgrades also include 131.8 miles of berm improvements and seepage control measures along with required access roads. This project provides protection for an area with a population of over 4.6 million people in 85 counties and parishes along the Mississippi River. This area has been identified as the MRL economic base study area. Indirectly, this project affects the entire Nation. Major cities, small towns, highly developed industrial areas, and vast farmlands are all dependent on the protection afforded by these levees.

THE ECONOMIC BASE AREA

8. The overall study area for the MRL project is displayed on Figure 7-1. It includes the total area located in three Corps Districts of the Lower Mississippi River Valley which are considered to be physically, socially, or economically impacted by the main stem levee project. This economic base area, which extends roughly from Cairo, Illinois, to the Gulf of Mexico, encompasses approximately 50,000 square miles of land area in seven states--Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee.

LOCATION

9. The Lower Mississippi River Valley is a relatively flat alluvial plain located in the Central Gulf Coastal Plain of the south-central United States (Figure 7-2). The valley, which begins just below Cape Girardeau, Missouri, ranges from 25 to 125 miles wide and spans approximately 600 miles in length to the Head of Passes in Louisiana. It is roughly bisected by the Mississippi River all the way to the Gulf of Mexico.

10. The economic base area begins in the vicinity of the Mississippi River's confluence with the Ohio River. At this point, it includes portions of three states--Illinois, Missouri, and Tennessee. The northernmost portion of the economic base area is situated in the Memphis District. Starting at Cape Girardeau, it extends southerly along the Mississippi River to Memphis, Tennessee. This segment contains approximately 17,900 square miles of land in 31 counties of 6 states. The Vicksburg District portion stretches from the Memphis District boundary southward to the Mississippi River's confluence with the Red River in Louisiana. With approximately 22,400 square miles of land area, it comprises almost one-half of the main stem levee economic base area. This section includes 36 counties and parishes in three states. The remaining segment, located in the New Orleans District, comprises the southernmost portion of the Lower Mississippi River region. Situated entirely in the State of Louisiana, this section covers approximately 9,000 square miles of land in 18 parishes along the Mississippi River from the Red River to the Gulf.

PHYSIOGRAPHY

11. The Mississippi River is one of the most powerful hydrologic resources in the Nation. Originating at Lake Itasca, Minnesota, it drains over 1,245,000 square miles of land from 31 states and 2 Canadian provinces on its route to the Gulf of Mexico. This waterway, which has been called "the Great River," "the Father of Waters," "Old Big Strong," "Old Man River," "Old Devil River," and "the Mighty Mississippi," is very unpredictable. It has a great wide flood plain and is relatively unconfined by nature. At Cairo, it becomes the lower Mississippi River.

FIGURE 7-1
ECONOMIC BASE AREA
FOR THE MRL PROJECT

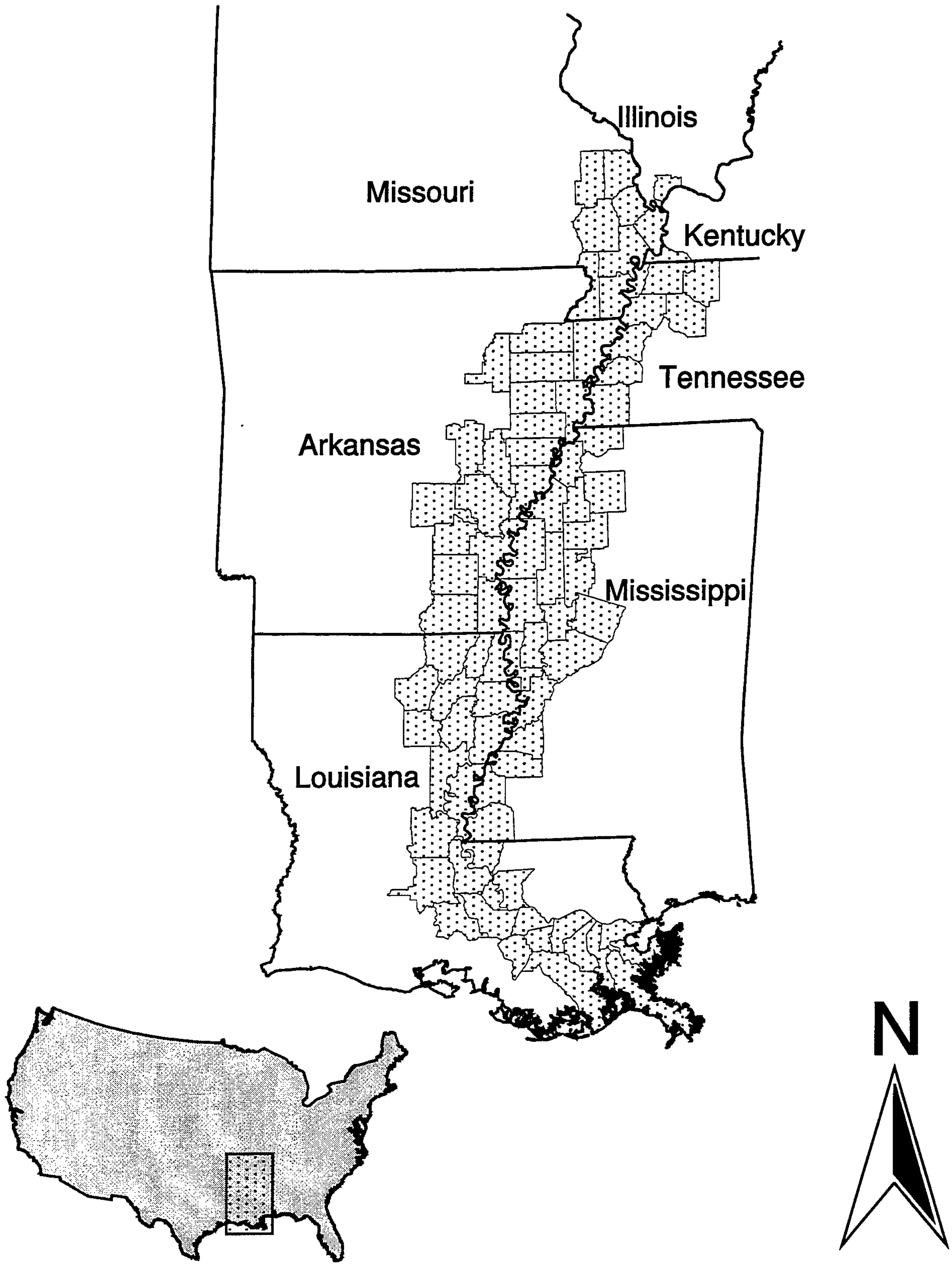
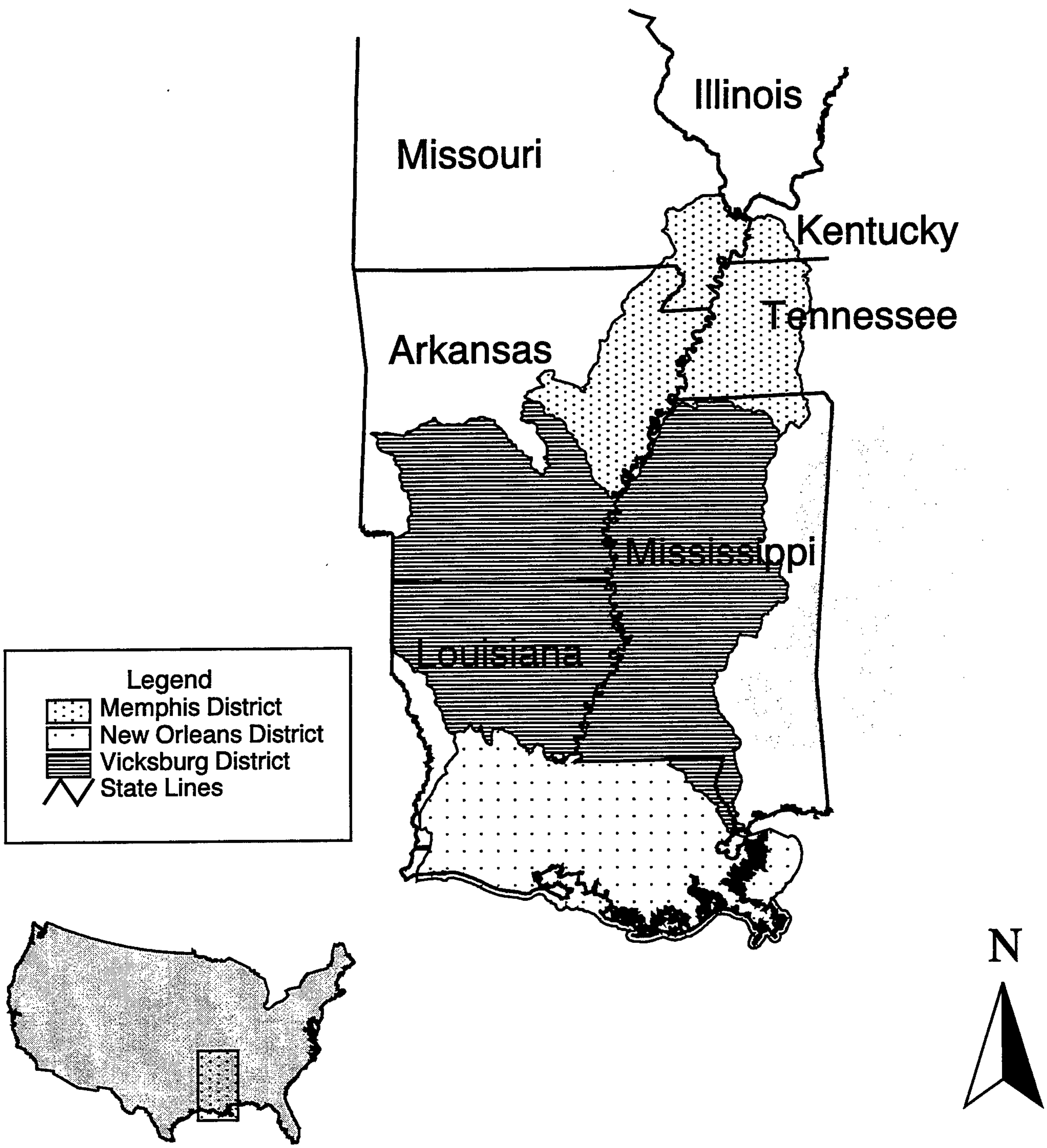


FIGURE 7-2
LOWER MISSISSIPPI RIVER VALLEY
BY U.S. ARMY CORPS OF ENGINEERS DISTRICT



Considered the giant among North American waters, the lower Mississippi River winds for approximately 954 miles on its erratic course to the Gulf, creating its own alluvial valley on the way. Because of this, man has been forced to undertake protective measures such as revetment and diversion structures to manage the constantly changing course of the River.

12. The MRL area is part of the rich, Deltaic region of the lower Mississippi River, which with its fertile alluvial soil, constitutes one of the most productive farming regions in the United States. The lower Mississippi River and its alluvial valley became deeply incised in the coastal plains area during the last glacial advance of the Pleistocene Period when sea level was several hundred feet lower than present. During and subsequent to this time period, as early as 5,000 to 6,000 years ago, the Mississippi River began development of the alluvial Delta valley. Each time the Mississippi River overtopped its banks, it deposited tremendous amounts of sand, silt, and clays in the valley, gradually filling it with layers of alluvium.

13. Today, the topography of this area is characterized by a flat to slightly undulating surface underlain by Holocene and Pleistocene alluvial and terrace deposits. With over 53,000 square miles of total alluvial valley, approximately 28,000 square miles are rolling to hilly land and 25,000 square miles are flat Delta. The Deltaic plain ranges in elevation from below sea level in the New Orleans District to 320 feet, National Geodetic Vertical Datum (NGVD), in the upper Delta of the Memphis District. The middle Delta area--the Vicksburg District--starts at approximately 100 feet, NGVD, and rises to about 200 feet, NGVD, in the upper reaches.

14. The lower Mississippi River has approximately 35,000 square miles of alluvial valley which is subjected to floodwater if not protected by levees. Sweeping across its flood plain in huge arcs, the Mississippi River divides the plain into large flood basins which are generally bounded by the bluffs of the valley wall on one side and the meander ridges of the River on the other. On the western side of the River, the Arkansas, Atchafalaya, Boeuf, Red, St. Francis, and Tensas River flood basins are prevalent. The eastern flood basins include the Fork Deer, Obion, and Yazoo River Basins. Meander scars throughout the valley indicate many former courses made by the Mississippi River and show visible signs that the western levees have crevassed more frequently than the eastern. Because of this, the Mississippi River tends to overflow more frequently westward into its alluvial valley and, in the vicinity of the Red River, has threatened to change course and take a more direct route to the Gulf--by way of the Atchafalaya River.

CLIMATE

15. The climate is generally mild throughout the MRL study area. Summers are basically long, hot, and humid, and winters are short and moderate. During winter months, the prevailing wind is from the north or northwest. In other seasons, winds are from the south and southwest. The normal annual temperature averages about 60 degrees F. Observed temperature extremes in

the area range from 115 to -16 degrees F. The normal annual precipitation averages approximately 50 inches. The heaviest rainfall in the lower Mississippi Valley normally occurs during the months of December to April, while minimum rainfall occurs normally during August through October. Severe rainfall, producing locally intense runoff, however, can occur at any time of the year. The normal length of the frost-free growing season is approximately 7 months in the total area. In the northern portion of the economic base area, average snowfall is 8 to 10 inches, with most of it falling from January to February. Meanwhile, the southern region might experience freezing rain and snow only one to two times annually with snow depths ranging from 1 to 3 inches.

HISTORY

16. The history of the MRL area corresponds with the early development of communities along the alluvial Delta of the lower Mississippi River. There are ritual Indian mounds along the River which served those who came after the Indians as lookout points and retreats from advancing floods. Also, here and there, a few old plantation mansions tell of the antebellum South.

EARLY INHABITANTS

17. The earliest known inhabitants were prehistoric men who lived in the area at least 10,000 years before Hernando de Soto and his Spanish soldiers came in search of gold in 1541. Little is actually known of their earliest occupation, but they left considerable evidence in village sites and burial mounds scattered throughout the project area. As long ago as 3,000 years, Indians farmed the wide Mississippi flood plain. Indian agriculture was not uncommon by the year A.D. 1000. However, early white men, particularly Spanish and French explorers, had much influence on the tribes, spreading diseases that decimated the Indian population. By the time the first European colonists arrived in the 1700's, the mound builders had all but vanished. Only small and scattered tribes such as the Choctaw, Chickasaw, and Natchez remained. The Indians, however, left a legacy in the name, Meche Sebe, or Misi Sipi, meaning "the Great River."

SETTLEMENT

18. Hernando de Soto was the first recorded explorer of the region. When de Soto entered the lower Mississippi River valley, he found the native population densely settled in large farm communities. Although there was no evidence of metal working or sculpture, some stone work was being done and pottery making and basket weaving were widespread. Although the natives were primitive in comparison to their European conquerors, they were the first shapers of the environment of the Mississippi River Delta. They taught the first settlers what game was good to hunt and what plants were good to collect or cultivate. Their crops were eventually developed by the Europeans into a worldwide commerce.

19. Nearly 150 years after de Soto, La Salle led his French expedition through the Mississippi River valley in 1682. La Salle claimed the entire drainage basin as a French colony. Near the end of the 17th century, d'Iberville landed on the Mississippi-Louisiana Gulf Coast and journeyed up the Mississippi River exploring some of its tributaries in addition to outlining the southeastern shore of Lake Pontchartrain. During this same period, Englishmen from the Carolina's moved into the area settling the north shore of Lake Pontchartrain. Both the French and English were fur traders, and each desired to monopolize furs trapped by the Indians. A trade war ensued which continued throughout the French Colonial Period, but it was agriculture rather than fur trading which encouraged the permanent settlement of the lower Mississippi River valley region.

20. Upon the end of the French and Indian War in 1763, the British took control of the area east of the Mississippi River. This resulted in the venturing of early American pioneers into the area, carving farmsteads from the forests which covered the natural levees along the River. In addition, as a result of Indian treaties of the 1830's, much Indian land was ceded to the U.S. Government creating an influx of settlers pouring into the Delta mostly from Virginia, South Carolina, Kentucky, and Tennessee. This has come to be known as "the Great Migration."

EARLY NAVIGATION

21. Traders began using the Mississippi River as a mode of transporting goods as early as 1705. Records show the first cargo was floated down the River from the Indiana-Ohio area to Baton Rouge, Louisiana, then through several bayous, rivers, and lakes in southern Louisiana and on to Biloxi, Mississippi. From there, the goods were shipped to France. Natchez, Mississippi, built as Fort Rosalie in 1716, was the first permanent white settlement on the Mississippi River followed by New Orleans, Louisiana, in 1718. These cities served as stopping points along the River. New Orleans rapidly grew with its location near the mouth of the River and the Gulf. Thus, navigation flourished and developed with the settlement of the lower Mississippi River valley.

22. The Indian canoes soon proved inadequate for the needs of settlers, and the flatboats and rafts that succeeded them were one-way craft only. The keelboat soon became the queen of the river trade. The keelboat was a long, narrow durable two-way traveler built to carry as much as 80 tons of freight. However, it had to use a strong crew of men to bank tow the boat back upstream.

23. In the early 19th century, the invention of the steamboat brought about a revolution in river commerce. The first steamboat was built in 1811 and, by 1816, major improvements had been made in which the boat could travel farther upriver. The number of steamboats grew from 21 in 1814 to 191 in 1819 and, in 1833, more than 1,200 steamboat cargoes were unloaded.

Navigable steamboat progress continued farther north to the upper Mississippi River and, by 1840, heavy river commerce from St. Louis, Missouri, to Minnesota was a reality. The steamboat could haul freight faster, provide comfortable accommodations for passengers, and could travel both upstream and downstream. Before the invention of the steamboat, a trip from Louisville, Kentucky, to New Orleans often required 4 months. In 1820, the steamboat made the trip in 20 days and, by 1838, the same trip was being made in 6 days. The packet boat brought a phenomenal increase in river traffic and, in 1849, there were approximately 1,000 packets with a total load of 250,000 tons. These continued as a principal means of transportation in the Mississippi River valley until the turn of the century when river commerce had been diverted to expanding railroads and diesel-driven waterborne vessels with greater towing power were introduced.

PLANTATIONS

24. Agriculture, primarily cotton, was the principal economic base for the Mississippi River Delta during the early 1800's. At first, agricultural development grew very slowly, primarily because of the large amount of labor required to clear the land. The northern portion of the area was the first to realize the value of the rich forest-covered Delta farmland. Land clearing began to occur at a very rapid rate following the advent of steamboat adaption for river transportation and the increased demand for high quality cotton.

25. This advancing cotton economy, as a result of fertile soil, and the availability of water transportation supported the development of the unique Southern plantation system. French land claims and family customs were also largely responsible for the evolution of plantations. These large farms provided economic advantages that caused their rapid expansion even though they required heavy capital investment, large land areas, and much cheap labor. Three events late in the French Colonial Period favored the development of plantations--the invention of the cotton gin, the process for crystallization of sugar, and the importation of slave labor. Single-crop plantations growing mainly sugarcane or indigo multiplied rapidly, but by the mid-1850's, most crops were being replaced by cotton. Lumbering also became an off-season adjunct of agriculture for plantations.

26. With steamboats providing accessible river transportation for hauling crops to market, cotton plantations developed along the Mississippi River as far north as the Ohio River. However, being located along the River, plantation owners maintained residences in bordering hills to avoid the malarial epidemics which often occurred in the Delta areas during overflows of the mighty Mississippi River. Overall, plantations evolved into self-contained communities whereby all their needs were supplied. They flourished both socially and economically. Only the Civil War brought an end to the South's unique plantation system, with its fine homes, aristocratic culture, and extensive slave holdings. However, a legacy of antebellum tradition and homesites is evident throughout the lower Mississippi River valley.

LAND CLEARING

27. After the Civil War, many of the large landholdings were broken into smaller units, and single-crop family farms were soon widespread. Lumbering became an intensive industrial activity in the late 19th century. Landowners realized a double return from the land as clearcutting for timber products was followed by cotton production which had become easier to transport to market by steamboat. Thus, wholesale land clearing ensued utilizing cheap Irish and Chinese immigrant labor. However, many died from malaria, and the disease threatened to squelch the settlement of the Delta. The discovery and use of quinine provided some protection and land clearing continued. Farmers from the central United States moved into the area in the early 1900's with visions of creating a second corn belt, but cotton remained "king." Around 1900, petroleum was discovered in the lower Mississippi River valley and, for the next several decades, there was a slow, but steady, increase in industrialization.

28. The rate of land clearing dropped during the depression of the 1930's and World War II. However, recovery of the Nation's economy after the war increased national demands for rice, cotton, and livestock. This generated additional land clearing by large farm enterprises and forested acreage steadily declined through the 1950's. Ranchers from the drought-stricken Southwest also moved into the area. Much of the estimated 900,000 acres cleared in the 1950's in the lower Mississippi River valley was attributed to the development of permanent pasture land for cattle. During the same time, there was an influx of industry along the banks of the Mississippi and its tributaries. Increasingly thereafter, economic emphasis shifted from agriculture to commercial forestry, mining, quarrying, petroleum production, and the manufacturing of food, textile, chemical, and paper products.

FLOOD CONTROL

29. Flood control is, and has historically been, a primary catalyst in the economic and physical development of the lower Mississippi River valley. Without flood control, the region could not sustain its present population, and those residing in the area would be under continuous threat of natural disaster. Without flood control provided by the present system of Mississippi River levees, the entire alluvial valley which contains the most productive soils in the region would be subject to frequent flooding.

NATIONAL INVOLVEMENT

30. In 1820, Congress began its long history of influencing the economic development of the alluvial valley by authorizing the expenditure of $5,000 for a navigation study of the Ohio and Mississippi Rivers by the Corps. In 1824, the Corps became involved in water resources basically because West Point was the only source of trained engineers in the Nation.

Improvements at the mouth of the Mississippi River for seagoing navigation were first undertaken by Congress in 1837 with an appropriation made for a survey of the passes and bars at the mouth. Approximately 12 years later, the floods of 1849 and 1850 caused widespread damage and destruction in the Mississippi River valley. Together with the growing river commerce, this created a demand for Federal participation in navigation improvements and flood protection. In the early 1850's, Congress expanded the authority for topographical and hydrological surveys in addition to conducting a Mississippi River Delta study. Unfortunately, contending political viewpoints over the propriety of Federally funded public works resulted in inconsistent funding that precluded efficient and consistent river management before the Civil War.

31. Between 1851 and 1874, various plans for improving the River were developed. The small cadre of Army engineers were asked to survey rivers, roads, and canals and remove snags from the Mississippi and Ohio Rivers to open the waterways for steamboats. In 1861, two West Point graduates (Captain Andrew Humphreys and Lieutenant Henry Abbot) published their study of the Mississippi, "Physics and Hydraulics of the Mississippi River." Their report, which aggregated a host of data, stated that "levees only" was the solution to flooding and suggested other approaches were not feasible. For the Corps, this became the Bible of the Mississippi River improvements for six decades, but subsequent events have since revealed its shortcomings. In the 1870's, one of the greatest navigation achievements was opening the mouth of the Mississippi River to ocean-going vessels which had frequently been impeded by sandbars. Utilizing dredging and a system of parallel jetties, a 30-foot channel was completed in 1879 near the mouth. During the same year, the Board of Engineers concluded that a complete levee system would aid commerce in periods of high water only. Their conclusion is noteworthy for considering flood control and navigation improvements as part of the same problem.

THE INFLUENCE OF NAVIGATION

32. The importance of the Mississippi River to the Nation was firmly established. Congress had shown an increasing interest in flood control and navigation problems on the Mississippi River and designed legislation to make improvements which would in turn benefit the Nation. Since 1896, progress has been made in developing and maintaining authorized navigation improvements along the Mississippi River from Cairo to below Baton Rouge, including channels ranging from 9 to 12 feet deep and 250 to 300 feet wide at low water. Prior improvements in the upper Mississippi River had primarily been limited to the removal of snags and closure of sloughs to confine low-water flows in the main channel. In 1907, Congress adopted a project channel depth of 6 feet on the River from just above St. Louis to Minnesota and, in the early 1930's, the depth was increased to 9 feet to be maintained utilizing a system of locks and dams. Since that time, many modifications have been made to the Mississippi River to improve inland navigation from its source to the Gulf, and near its mouth, channels have been increased to depths of up to 40 feet and 1,500 feet in width to accommodate ocean-going traffic.

33. Other navigation advances have also occurred in support of national interstate commerce. Today, intracoastal channels through southern Louisiana and Texas provide waterborne access from the lower Mississippi River to the southwestern United States and Mexican borders; and intracoastal waterways through southern Mississippi, Alabama, and Florida connect the lower Mississippi River to the southeastern portion of the country. Other waterways and navigational projects through the Nation's heartland have also been or are nearing completion. These include commercial connections to numerous water bodies, including the Great Lakes, and at least 17 states through the central region of the country--Alabama, Arkansas, Florida, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, Ohio, Oklahoma, Tennessee, and Texas.

THE MISSISSIPPI RIVER COMMISSION

34. The first concerted flood control program began with the establishment of the Mississippi River Commission (CEMRC) in 1879 as a result of a recognized need for coordinating improvements and engineering operations through a centralized organization. Prior to that time, piecemeal protection of flood plains was carried out by levee districts formed by state legislatures. The CEMRC was charged with creating a comprehensive plan to facilitate navigation and prevent destructive floods.

35. After great back-to-back floods in 1912 and 1913 which caused many deaths and left hundreds homeless, Congress at last authorized flood control resulting in hundreds of miles of levees being raised and strengthened. The CEMRC had become complacent that the "mighty Mississippi" was finally somewhat controlled. However, in 1927, a great flood erupted in the alluvial valley which inundated over 26,000 square miles of land and caused over $236 million in property damage (current 1927 dollars). Approximately 325,000 people required emergency relief and care when they were driven from their homes. It was evident that the "levees only" approach was not the total answer. In 1928, Congress directed the Corps to develop a flood control system which would prevent such massive flooding from ever occurring again.

THE 1928 FLOOD CONTROL ACT AND THE MR&T PROJECT

36. After reviewing over 300 competing flood control plans, Congress finally adopted the proposal of Major General Edgar Jadwin, Chief of Engineers, in 1928. The Jadwin Plan had two principal innovations--floodways would be used to divert peak flows and maintain stages in the main channel, and all works would be designed according to a "project flood" using historic rainfall and runoff patterns. This Plan and its comprehensive approach to the River's management resulted in the MR&T Project authorized by Congress in the Flood Control Act of 1928. The MR&T Project included levees and floodwalls to contain floodflows and a main stem levee system extending from Cape Girardeau nearly to the Gulf of Mexico. The protection was continuous except where major tributaries enter the Mississippi River or where natural high ground made them unnecessary.

37. The current construction program consists of raising and strengthening the existing levees as well as building berms and other features. The system is vast. Some 3,714 miles of levees have been authorized for the MR&T with 3,410 miles in place and 2,786 miles in place to grade and section. On the main stem of the Mississippi River, 1,602 miles of levees are in place. Work on the main stem levees is approximately 89 percent complete, and the tributaries portion is approximately 75 percent complete.

38. Managing the "Great River" is difficult due to the alluvial nature of its valley. In its natural condition, the River meanders back and forth with few bluffs or other features to constrict its course. Consequently, CEMRC has developed open river improvements that attempt to confine, train, and stabilize the Mississippi River's channels and banks while providing navigational and other water resources opportunities and alleviating flooding in accordance with strict environmental standards.

ENVIRONMENTAL CONSIDERATIONS

39. During the past two decades, environmental considerations have been a major part of the Corps mission reflecting a broader range of considerations such as reforestation, saltwater intrusion, endangered species, wildlife habitat, and wetlands. Numerous environmental initiatives are underway, including extensive reforestation activities that encompass approximately 30,000 acres in the Yazoo River Basin in Mississippi. Programs and activities consider sensitivity to endangered species such as the Least Tern which has numerous nesting areas along the Mississippi River. Since 1981, the Corps has been engaged in a comprehensive environmental program to develop information on natural resources within the unprotected Mississippi River corridor from Cairo to the Gulf. Major objectives include conducting inventories within the flood plain and developing environmental design guidelines and criteria for engineering works.

ECONOMIC CONSIDERATIONS

PROJECT SIGNIFICANCE

40. The Mississippi River has made major contributions to the physical and economic growth of the lower Mississippi River valley region and the main stem levee area. Regionally, it has provided tremendous potential for meeting water supply and water transportation needs for industrial and agricultural development. Also, comprising over 12,000 miles of inland waterways, the Mississippi River system has supported the ever-growing commerce of the Nation as the main stem of a major navigation network. The Mississippi River carries over 500 million tons of commerce annually. As the chief supplier of water for the many industries

which have located along its banks, it is one of the Nation's greatest industrial attractions. The Mississippi River also serves as the major drainage outlet for runoff from over 41 percent of the 48 contiguous states of the United States. Extending from its tiny source at Lake Itasca in northwest Minnesota southward for more than 2,300 miles to the Gulf of Mexico, the entire Mississippi River drainage basin covers more than 1,245,000 square miles and includes all or parts of 31 states and 2 Canadian provinces. Water from as far east as New York State and as far west as Montana contributes to flows in the lower Mississippi River.

41. A significant portion of national prosperity is contributed by the lower Mississippi River valley region. This area is the site of one of the oldest commercial agricultural regions in North America and lies in the heart of the most diverse hydrologic system in the Nation. In 1970, the lower region handled 1 of every 7 tons of waterborne commerce in the United States, supplied from one-fourth to one-third of the Nation's energy, made substantial contributions to national food and fiber requirements, and supported $8 billion in industrial development along the lower reaches of the River.

PROJECT IMPACTS

42. Although throughout history the Mississippi River has been the basis for the agricultural economies which have developed along its banks, commerce and industry have emerged over recent years. Dependent on the River's abundance of water as a natural resource are industries such as hydroelectric and nuclear powerplants, grain elevators, paper mills and other forest-related firms, numerous other manufacturing firms, and industries interested in waterborne transportation. Over the last decade, gaming industries have also been attracted to the region based on the history and location of the Mississippi River. All these factors have helped diversify the local and regional economies which have historically been rural in nature, with the exception of a few major metropolitan areas.

43. Capitalizing on a market of available natural resources, investments have been made in the production as well as the protection of the region's resources. Failure of the Mississippi River levees during the time of a major flood event would allow the destruction of crops, homes, and industries causing many billions of dollars in damages. Businesses and lives would be interrupted. Major flooding in the Delta regions would bring the commerce of cities and towns to a halt and deliver a devastating blow to the lives and spirits of the people who reside there.

44. Based on the significant influence of the Mississippi River on surrounding economies, it is not hard to grasp the importance of the main stem levee system to the region. Protecting approximately 22 million acres of land in the States of Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee of the lower Mississippi River valley, it has the task of trying to contain one of the oldest and most powerful natural resources in the world--the Mississippi River.

OTHER CONSIDERATIONS

45. Additionally, when considering the combined effects of the MRL project and river control features of the MR&T Project, there could be other catastrophic impacts in the absence of project implementation. There is a great possibility that the Mississippi River could change its course near the confluence of the Red and Mississippi Rivers. By providing a shorter outlet to the Gulf, the Atchafalaya River threatens to steal the flow of the Mississippi River. In this event, severe repercussions would take place. The Atchafalaya River Basin could not accept the Mississippi River flow without massive flooding, extensive relocations, and the upheaval of the social and economic patterns of the area. Also, the cumulative impact of flood elevations from both the Atchafalaya River and main stem flooding would heighten damages and losses in the lower Mississippi River area. If the Old River Control Structure which controls the flow of water into the Atchafalaya River failed, the new route of the Mississippi River would render hundreds of millions of dollars worth of existing flood control projects and investments useless along the lower Mississippi River, including portions of the MRL project.

46. Industries and economies of the lower Mississippi River are also reliant on the freshwater resources of the Mississippi River. These groups cannot afford to have salt water ponding from the Gulf of Mexico back up into the lower reaches of the Mississippi River. The main stem levee will help retain the Mississippi River waters within its banks and alleviate some of the cumulative effects of possible overflow flooding from both the Atchafalaya and Mississippi Rivers simultaneously. Corporations have constructed billions of dollars worth of petrochemical plants, refineries, grain elevators, and fossil fuel and nuclear power-generating plants, most of which depend on fresh water for their manufacturing process. Cities below Baton Rouge, including New Orleans, would be required to find freshwater drinking sources which would require additional investments. In addition, the tremendous volume of shallow draft navigation which occurs between Baton Rouge and the Gulf, including the Port of New Orleans, would most probably be disrupted.

IMPACTS FROM MISSISSIPPI RIVER FLOODING

47. The alluvial Delta of the Mississippi River is subjected to significant loss and damage in times when the Mississippi River overflows its banks. Flooding large acreages of land, the region experiences major flood damage to farmland, homes, businesses, personal property, roads, and bridges. Also, many times people are without shelter, utilities, and food and are inconvenienced by an interruption in daily activities and loss of income. The following section discusses flood damage estimates for the lower Mississippi River valley region in terms of damage prevented by the project.

FLOOD DAMAGE ESTIMATES

48. The levees along the Mississippi River protect one of the most productive agricultural areas in the world, in addition to many other developments which have occurred over the years. Annual reports to Congress provided by the Corps show that a cumulative total of flood damages prevented by the MRL was estimated to be $182 billion (current dollars) through Fiscal Year 1996 for the entire lower Mississippi River Basin.

49. In flood damage estimates provided by the Vicksburg District, the levees prevented approximately $930 million in annual flood damages over the last decade and a total of $46 billion in flood damages within the Vicksburg District since construction began in the 1930's. In 1973, high stages on the Mississippi River and heavy local rainfall combined to cause a major flood event in the Vicksburg District. It was estimated that $13.6 billion in flood damages were prevented during this single event from all flood control works in the Vicksburg District, with the majority of benefits arising from the main stem levees. Flood damages of this size would almost certainly be accompanied by the threat of loss of life and would devastate millions of acres of farmland, numerous communities, homes, and businesses. When combined with potential damages in the other two Districts, the possibility of a flood of this magnitude would be catastrophic to the economy of the region and repercussions would be felt throughout the entire U.S. economy.

CASE STUDIES OF EXPECTED DAMAGES

50. A recent study was conducted by the Vicksburg District to determine the expected damages from crevasses in the Mississippi River levee at Mayersville, Mississippi, and Lake Providence, Louisiana. Although limited, this study provides an indication of how catastrophic the impacts from a levee failure would be to the rest of the MRL study area.

51. Located in the central Delta region of the Vicksburg District, crevasses near the small towns of Mayersville and Lake Providence would directly affect approximately 114,000 people, 40,000 residences, and 1,600 businesses in 12 counties and parishes along the Mississippi River. Results of damage analyses indicate levee crevasses could potentially cause $4.6 billion in direct flood damages--$1.6 billion in the areas along east bank of the Mississippi River and $3.0 billion on the west bank. Secondary and tertiary impacts could increase the total effect on the local economy to almost $10 billion. This would have a devastating effect on the economy of this region. Both agricultural and industrial interests would be adversely affected and would require a significant amount of time to recover. Millions of dollars in business losses would occur with thousands of additional people indirectly impacted by the setback in commerce. Traffic corridors such as Interstate Highway 20; U.S. Highways 61, 65, and 84; and other

corridors, including railroads, could be closed for months, forcing the rerouting of thousands of vehicles. The true cost of this disaster cannot be fully explained in economic terms, however. Given the high probability of loss of life and the devastation experienced by individual families and communities, there would be both a huge toll in human suffering and economic activity which could take years to overcome.

52. Representing only 14 percent of the MRL economic base area, results of this study indicate levee failures at other locations would cause even more astronomical damages and impacts regionwide. In the total MRL area, there are approximately 4.6 million people and 1.6 million residences affected in 85 counties and parishes. This is 40 times the number of people and structures affected in the Vicksburg District crevasse study and residential values are 50 to 100 percent higher in the other two Districts. Based on simple extrapolation of this case, damages to the entire MRL area would be estimated to approach $300 billion. The aim of the main stem levees is to protect the region from a potential flood event of this magnitude.

53. An additional analysis was conducted by the Memphis District during the flood of 1993 to estimate the damage which could occur from a crevasse of the Birds Point to Commerce levee. The Birds Point to Commerce levee is located on the west bank of the upper Mississippi River reach of the Memphis District. It protects the bootheel of Missouri and the upper delta area of Arkansas. Cities potentially affected by a crevasse include Sikeston, Charleston, and East Prairie in the State of Missouri and Jonesboro and Paragould in the State of Arkansas. A crevasse of this levee assuming 1993 flood flows would have inundated approximately 1,000,000 acres of prime farmland and another 100,000 acres of wetlands, woodlands, and urban areas. Also damaged would be 23,500 residences and 1,500 commercial structures. Approximately 67,000 people would be affected. Potential direct flood-related losses were estimated at $598 million based on 1997 price levels. These losses consist of $307 million to structures, $224 million to agricultural activities, $56 million to roads, and $11 million for evacuation and other miscellaneous damages. Secondary and tertiary impacts could increase the total effect on the local economy to almost $1.3 billion.

54. This estimate was revisited during the MRL SEIS to address the potential effects of a crevasse during a Project Design Flood (PDF). The PDF on the upper Mississippi River would inundate a significantly larger area and cause much greater flood damage. The results of this analysis estimated that approximately 1,390,000 acres of prime farmland and 140,000 acres of other lands would be flooded along with 32,600 residences and 2,100 commercial structures. The flooding would affect approximately 93,000 residents. The potential damage was estimated at $828 million (1997 dollars) which is comprised of $426 million to structures, $310 million to agriculture, $77 million to roads, and $15 million to evacuation and miscellaneous damages or losses. Secondary and tertiary effects could increase the total local effect to almost $1.8 billion.

A SOCIOECONOMIC OVERVIEW OF PROJECT IMPACTS

55. This report has described the historical and national significance of the area. It has depicted how the economies of the region are reliant, not only on the waters of the Mississippi River itself, but on the agricultural and industrial bases which have developed as a result of the River. Discussed in greater detail in Section 3, these bases support both the demographics and economics of the areas and communities within the MRL region. A socioeconomic overview for 1990 conditions is presented in Table 7-1 indicating the extent of potential project impacts in the area.

TABLE 7-1
1990 SOCIOECONOMIC STATISTICS FOR THE
TOTAL MRL AREA BY DISTRICT a/

Socioeconomic Category	Vicksburg District Study Area	Memphis District Study Area	New Orleans District Study Area	Total MRL Area
Number of Counties/Parishes	36	31	18	85
Land Area (Square Miles)	22,396	17,944	8,993	49,333
Total Population	930,291	1,704,010	1,937,085	4,571,386
Number of Population Centers b/	12	18	25	55
Total Number of Households	318,802	629,817	696,215	1,644,834
Median Household Value ($) c/	47,500	67,600	81,200	69,500
Total Employment	329,523	739,942	791,059	1,860,524
Per Capita Income ($) c/	10,700	14,400	22,400	17,000
Total Earnings ($million) c/	9,636	25,247	29,555	64,438
Total Number of Manufacturing Establishments	957	2,195	1,570	4,722
Total Value Added by Manufacturing ($million) c/	3,584	12,408	12,391	28,383
Total Number of Farms	13,124	16,010	5,115	34,249
Total Value of Farm Land and Buildings ($million) c/	6,669	4,300	2,118	13,087
Total Value of Farm Products Sold ($million) c/	2,113	2,288	526	4,927

a/ Statistics presented for 1990 represent the closest year census data were available.
b/ With greater than 10,000 persons.
c/ Values expressed in constant 1996 dollars.

SECTION 3 - SOCIOECONOMIC ANALYSIS: MR&T PROJECT MISSISSIPPI RIVER MAINLINE LEVEES

INTRODUCTION

56. This section presents the results of a socioeconomic analysis of the area affected by the MR&T main stem levee project. It covers the area impacted in three Corps Districts--Vicksburg (CEMVK), Memphis (CEMVM), and New Orleans (CEMVN). To illustrate the social and economic well-being in the area affected by the main stem levees, a data base of socioeconomic growth and development parameters was created utilizing past and present economic conditions. These parameters were used to analyze the existing socioeconomic environment of the region and determine the future direction of the area's demographic and economic growth.

57. Section 3 provides a socioeconomic profile of the MRL area including demographic and economic information deemed pertinent to the implementation of the project. This section contains a general discussion of existing conditions in terms of natural, physical, and economic resources and expected future trends of various economic indicators. The socioeconomic environment prevalent in each Corps District portion of the study area is also discussed in this section. However, due to the massive amount of information accumulated for the evaluation, the detailed county/parish data are presented in tabular form in separate attachments. Attachment 7-A includes detailed information for the Vicksburg District portion of the MRL area, Attachment 7-B for the Memphis District, and Attachment 7-C for the New Orleans District.

ECONOMIC BASE AREA

58. The MRL economic base area, previously displayed on Figure 7-1, includes the area considered to be physically, socially, or economically impacted by the Mississippi River main stem levee project. This economic base area encompasses about 50,000 square miles of total land area in seven states--Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. To illustrate the magnitude of the numbers and specific areas affected by the project, the economic base area counties/parishes are shown by total land area in square miles in Table 7-2. This includes a numerical count and listing of the counties and parishes affected in each District by state. Further reference to counties will be inclusive of parishes unless otherwise stated.

59. The northernmost region of the MRL area is located within the bounds of the Memphis District. This area covers approximately 17,900 square miles in total land area in 31 counties of 6 states--12 counties in Arkansas; 1 county in Illinois; 1 county in Kentucky; 1 county in Mississippi; 8 counties in Missouri; and 8 counties in Tennessee.

TABLE 7-2
1990 LAND AREA OF THE MRL ECONOMIC BASE AREA

CEMVK - VICKSBURG DISTRICT						CEMVM - MEMPHIS DISTRICT						CEMVN - NEW ORLEANS DISTRICT		
Study Area by State		Sq. Mi.	Study Area by State		Sq. Mi.	Study Area by State		Sq. Mi.	Study Area by State		Sq. Mi.	Study Area by State		Sq. Mi.
ARKANSAS		**4,604**	**MISSISSIPPI**		**11,267**	**ARKANSAS**		**8,399**	**MISSOURI**		**4,578**	**LOUISIANA**		**8,993**
1	Ashley	921	1	Adams	449	1	Arkansas	989	1	Bollinger	621	1	Ascension	292
2	Chicot	644	2	Bolivar	876	2	Craighead	711	2	Cape Girardeau	579	2	Assumption	339
3	Desha	765	3	Claiborne	489	3	Crittenden	611	3	Dunklin	546	3	Avoyelles	833
4	Drew	828	4	Coahoma	554	4	Cross	616	4	Mississippi	413	4	East Baton Rouge	456
5	Jefferson	885	5	Holmes	756	5	Jackson	634	5	New Madrid	678	5	Iberville	619
6	Lincoln	561	6	Humphreys	418	6	Lee	602	6	Pemiscot	493	6	Jefferson	306
LOUISIANA		**6,525**	7	Issaquena	413	7	Mississippi	898	7	Scott	421	7	LaFourche	1,085
			8	Jefferson	521	8	Monroe	607	8	Stoddard	827	8	Orleans	181
1	Caldwell	530	9	Leflore	592	9	Phillips	693	**TENNESSEE**		**4,087**	9	Plaquemines	845
2	Catahoula	704	10	Panola	684	10	Poinsett	758				10	Pointe Coupee	557
3	Concordia	696	11	Quitman	405	11	Prairie	646	1	Dyer	511	11	St. Bernard	465
4	East Carroll	422	12	Sharkey	428	12	St. Francis	634	2	Gibson	603	12	St. Charles	284
5	Franklin	623	13	Sunflower	684	**ILLINOIS**		**201**	3	Lake	163	13	St. James	246
6	Madison	624	14	Tallahatchie	644	1	Pulaski	201	4	Lauderdale	471	14	St. John the Baptist	219
7	Morehouse	794	15	Tunica	455	**KENTUCKY**		**209**	5	Obion	545	15	St. Landry	929
8	Ouachita	611	16	Warren	581	1	Fulton	209	6	Shelby	755	16	St. Martin	740
9	Richland	559	17	Washington	724	**MISSISSIPPI**		**470**	7	Tipton	459	17	West Baton Rouge	191
10	Tensas	603	18	Wilkinson	674	1	DeSoto	470	8	Weakley	580	18	West Feliciana	406
11	West Carroll	359	19	Yazoo	920									
Total CEMVK Study Area					**22,396**	**Total CEMVM Study Area**					**17,944**	**Total CEMVN Study Area**		**8,993**
												TOTAL MRL STUDY AREA		**49,333**

60. With approximately 22,400 square miles of land area in three states, the Vicksburg District portion of the study area comprises almost one-half of the total land area in the economic base area. It includes 6 counties in Arkansas, 11 parishes in Louisiana, and 19 counties in Mississippi.

61. The New Orleans District segment is the southernmost portion of the lower Mississippi River region. It is located entirely in the State of Louisiana and covers about 9,000 square miles of land in 18 parishes along the Mississippi River from the Red River to the Gulf.

THE EXISTING SOCIOECONOMIC ENVIRONMENT

62. Socioeconomic impacts from the MRL project are discussed in the following paragraphs regarding the area's existing and potential natural, human and economic resources. By providing protection against the devastation of the project design flood, the completion of this project would have a positive influence on local and regional economies in the area. Impacts from a flood event of this magnitude would directly affect population, housing, employment, per capita income (PCI), earnings, agricultural production, industrial expansion, and business volume.

NATURAL RESOURCES

63. The MRL area is favored with an abundance of natural resources. Highly productive agricultural lands, wildlife and fishery resources, forested area, lakes, streams, and wetland areas are the most valuable physical resources in the region. Other features include stream tributaries, abandoned channels, oxbow lakes, back swamps, natural levees, and rolling hill land.

64. The Mississippi River has a significant influence on the current and future development of natural resources which lie in its vicinity. Originally, the River was just a way of life and survival. It was the basis for developing civilizations and cultures living near the River and using the land to obtain the basic needs for survival. People migrated into the region from other areas and found the Mississippi alluvial plain to be rich in water, game, and trees which provided for most of their essential needs--water, food, clothing, and shelter. They also discovered the land to be fertile and very productive for growing crops. This eventually led to the flourishing agricultural economy for which the region is most noted.

65. The Mississippi River and its heritage have also been a primary catalyst in attracting people, industry, and business to the region. Esthetically, the scenery is beautiful and the population is relatively sparse. The environment is filled with vast natural resources such as

lakes, streams, forests, minerals, and wildlife areas which appeal to the needs of potential incoming industry. The rural atmosphere is an attraction to persons of retirement age and those hoping to escape the fast pace of the large city. With its heritage of the Civil War, steamboats, river boat gambling, and antebellum culture, the area is also a draw for gaming industries and history enthusiasts. Many communities have capitalized on the River's history to attract business, industry, and tourism. In turn, these enterprises have influenced the development of other trade, services, and commerce in the area.

LAND USE

66. Computerized satellite surveys by the Corps Geographic Information System (GIS) in 1997 were used to identify existing land use distributions in the MRL area. Due to their availability and the extensive efforts and time which would have been required to survey all of the counties in the study area, these data were deemed sufficient to depict the general types of land use prevalent. These surveys, which represent a 50 percent survey of the study area, provide a reasonable base for the majority of the MRL area. Additionally, it should be noted that metropolitan areas will have varying distributions of residential, commercial, industrial, and other types of urban use in accordance with the extent of urban development which exists. For example, large metropolitan centers may have large percentages of commercial, industrial, and municipal uses, and suburban areas near large metropolitan centers may have higher percentages of residential land use. Urban land use distributions in rural towns and communities may seem small in comparison to other land types. This is basically because they are calculated against the total land acreage in a county.

67. A sample of existing land utilization determined for the MRL area is presented in Table 7-3. Total acreage delineations from the GIS surveys cover approximately 16.9 million acres, or 50 percent of the study area. According to the area depicted by the GIS surveys, cleared lands (representing agricultural land and pastures) accounted for 72 percent of the total land use in 1997, while other nonurban uses such as forest lands, water bodies, wetlands, and other lands represented 26 percent. Urban land, which comprised the remainder, included developed areas such as residential, commercial, industrial, and other built-up urban-related areas.

TABLE 7-3
1997 SAMPLE OF LAND USE DISTRIBUTIONS IN THE MRL STUDY AREA
(percent)

Study Area	Urban Use	Nonurban Use							Total Land
		Cleared Land			Other Land			Total	
		Cropland	Pasture	Total	Woodland	Water	Total		
TOTAL	2	64	8	72	21	5	26	98	100

WATER RESOURCES

68. As illustrated on Figure 7-3, a major natural resource of the study area is the abundance of water. The MRL area includes several main stem tributaries. Along with underground aquifers, these provide practically limitless water supplies to the area. However, some localized problems with aquifer drawdowns are occurring. These problems are being addressed by several agencies. Also, numerous streams, lakes, ponds, and wetland areas are scattered throughout the area which provide habitat for wildlife and opportunities for outdoor recreation as well as esthetic enhancement of the communities.

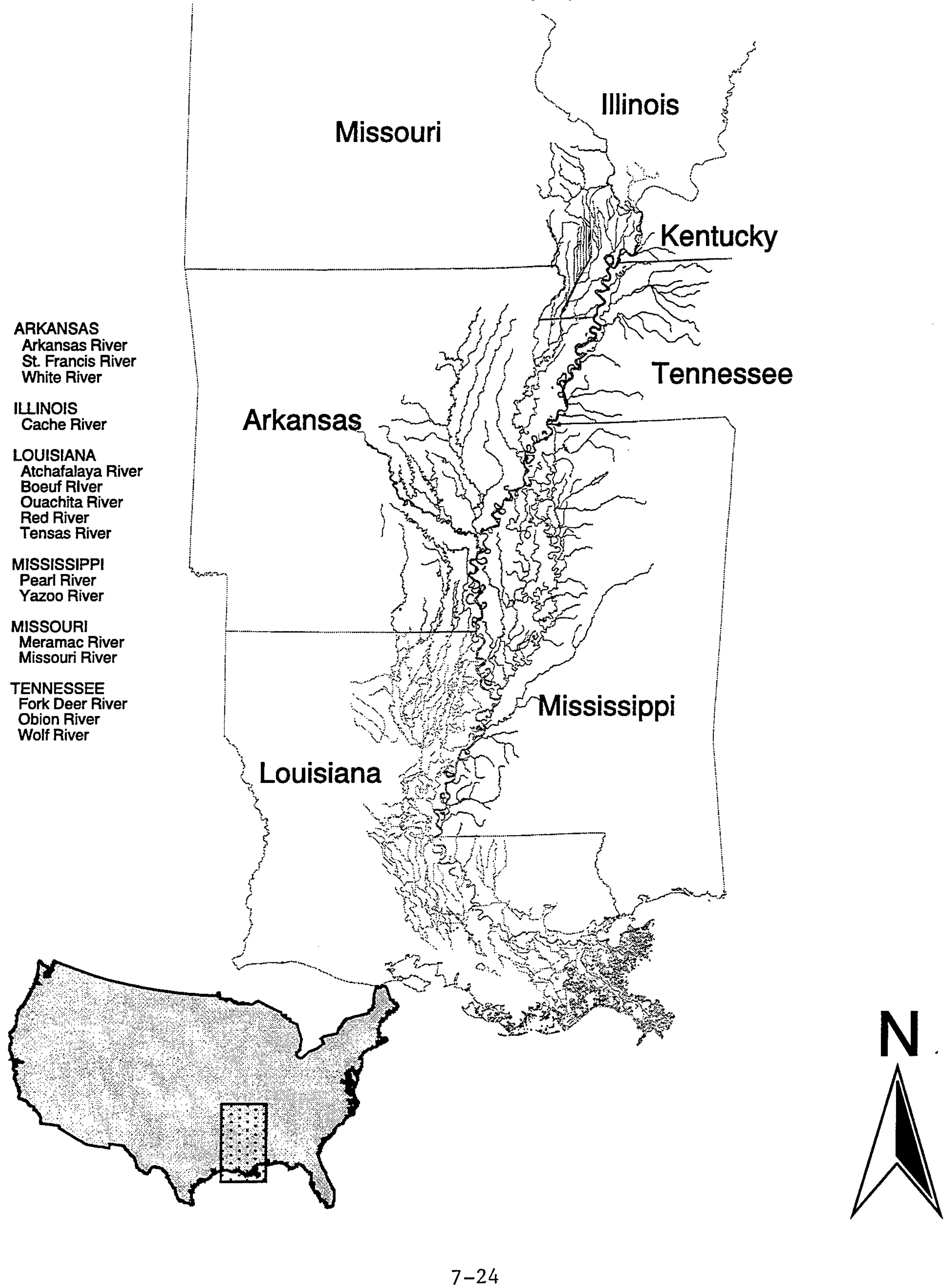
69. The MRL area is "water rich," but water resources are not unlimited nor is the distribution of water uniform. The largest and most prolific aquifer--the Mississippi River valley alluvial aquifer--is perhaps the largest single source of fresh ground water in the Nation. This shallow source of water is underlain by a complex system of artesian aquifers in Paleozoic, Cretaceous, Tertiary, and Quaternary rocks, some of which contain fresh water at depths of more than 3,000 feet.

70. Numerous surface-water resources supply the area. Among these are the Mississippi River; the Arkansas, St. Francis, and White Rivers in the State of Arkansas; the Cache River in the State of Illinois; the Atchafalaya, Boeuf, Ouachita, Red, and Tensas Rivers in the State of Louisiana; the Ohio River in the State of Kentucky; the Yazoo River in the State of Mississippi; the Meramac and Missouri Rivers in the State of Missouri; the Fork Deer, Obion, and Wolf Rivers in the State of Tennessee; and many other tributaries.

71. A distinct characteristic of the Mississippi River and other alluvial streams is the formation of natural levees along the banks and the pattern of parallel drainage which results from these levees. When the Mississippi River overflows, it deposits a part of the sediment it has been transporting. This sediment, most of which is deposited adjacent to the River, forms low natural levees along the stream with smaller deposits of sediment away from the stream. As a result, the banks of the River are usually 10 to 15 feet above the adjacent lowlands. The formation of these levees occurred for the most part before the present levee system was built. Because of the natural levees, drainage is usually away from and parallel to the Mississippi River except where tributary streams join the River. This pattern of drainage has been a great advantage in the construction of flood control works since it permits the building of long, unbroken levee lines without interfering with drainage.

72. Today, the Mississippi River provides the Nation with valuable navigational potentials and plentiful water supplies. Providing waterborne access to about 17 states through the central region of the country, the River supplies a major source of inland navigation for commerce moving over 500 million tons of goods annually. Low-cost shipping rates are also a favorable attraction for large-scale industries. In addition, the River supplies a substantial portion of the region's water supply for household, industrial, and civic purposes and has been used to

FIGURE 7-3
MAJOR RIVERS, STREAMS, AND TRIBUTARTIES IN THE MRL STUDY AREA



ARKANSAS
- Arkansas River
- St. Francis River
- White River

ILLINOIS
- Cache River

LOUISIANA
- Atchafalaya River
- Boeuf River
- Ouachita River
- Red River
- Tensas River

MISSISSIPPI
- Pearl River
- Yazoo River

MISSOURI
- Meramac River
- Missouri River

TENNESSEE
- Fork Deer River
- Obion River
- Wolf River

generate electrical energy for millions of customers throughout the Mississippi River valley. Technology is continually being developed to utilize water conductive power. Future potentials are unlimited. The Mississippi River's abundance of water will continue to influence the production of crops and accommodate the water supply demands for the region.

FORESTRY RESOURCES

73. Forests and forestry products have historically played an important role in the development of the lower Mississippi River valley. As lands were cleared for farming, settlers realized the benefit of selling the forest products for profit and, by the 1850's, the lumbering industry emerged as an off-season adjunct for cotton production. The accessibility of forest lands, the availability of local markets, and the presence of an excellent road and river system have all contributed to the rapid development of the production of forest resources in the MRL area. Through the years as land clearing practices increased, forest acreages declined. Also, forests are becoming increasingly restricted to areas where flooding, poor drainage, and soil conditions make it unsuitable for other uses. In recent years, since the emergence of manufacturing, trade, and services industries, forestry production is not as important as it once was to the local economies.

74. Based on statistics reported by the Department of Agriculture and Forestry for each state, approximately 35 percent of the land area in the MRL area is forest land today as compared to 42 percent in 1950. Although most of the decline is mostly the result of intense land development practices, some of the reduction can also be attributed to commercial forestry production. In efforts to restore the environment, the Corps, along with other Federal agencies and private groups, has been attempting to increase forest land acreage in the lower Mississippi River valley.

75. Forest land in the study area consists primarily of bottom-land hardwoods, mostly the oak-gum-cypress type. Other forest types include oak-hickory, loblolly shortleaf pine, longleaf-slash pine, and elm ash-cottonwood. The fertile lands of the Deltaic region produce some of the finest hardwood forests in the Nation, providing viable sources for the lumber, pulp, veneer, and miscellaneous forest products industries. Bottom-land hardwood areas also support outdoor recreation and valuable wildlife habitat, such as deer, turkey, small game, and nongame species.

MINERAL RESOURCES

76. The lower Mississippi River valley is rich in minerals, supplying approximately 20 percent of the Nation's mineral output. Major contributors to national mineral production are natural gas, petroleum, lead, bromine, salt, and sulfur. Other minerals produced in this area are natural gas liquids; metallic minerals such as copper, iron, silver, vanadium, and zinc; and nonmetallic minerals such as abrasives, barite, cement clay gemstones, gypsum, lime, sand, gravel, and stone.

77. Sand and gravel, which are numerous and widespread throughout the area, are two of the most important mineral resources utilized within the region. They are used in construction as well as glass production and molding industries. Because of their abundance, clays, which are used in making bricks, also rank among the most important resources in the economic base area. However, because of the emphasis placed on agricultural and forest production, clay is one of the most underutilized mineral resources in the MRL area.

HUMAN RESOURCES

78. The number of persons living in an area signifies the economic opportunities available in that area since this relates directly to the amount of economic and industrial activity present. Thus, population is used as an indicator of labor requirements in industry and commerce and of local demands for community facilities and public services. Impacts from not completing the MRL project can have detrimental impacts on the social behavior of the population and steady flow of economic activity in the area. Damages and losses from a flood event can, in turn, adversely affect the employment, industry, income, spending patterns, and general economy of an area. Human resources in the region are discussed in the following paragraphs in terms of their effect on economic growth.

POPULATION

79. Various parameters of the population can be used to determine the socioeconomic climate and viability of an area. Population is the base for the existing and future labor supply available to industry, and the quantity and quality of human capital are in turn reflected in employment and income returns to individuals. Changes in the population, composition, and distribution of an area all result from changing economic opportunities. These changes are exhibited in migration to cities and the suburbanization and exurbanization of those cities. Population by age class distribution (another indicator of economic activity) reflects the availability of the population as a labor resource and indicates the existing potential demand for various goods and services.

Population Statistics

80. Population for the overall 7-state area exceeded 4.6 million in the year 1990. Historically, population totals for the overall region have gradually increased. However, there have been some periods of outmigration in localized rural areas where the number of persons moving out of an area was greater than the combined number of immigrating residents and the natural population growth.

81. Historical population data for the MRL area are displayed by Corps District in Table 7-4 for the years 1960 to 1990. Growth statistics show the overall study area population has increased by over 500,000 people since 1960 or 14 percent over the 30-year period. This has been a consistent growth with the exception of the last decade. Each District study area, except Vicksburg, has also experienced increases. Population in the New Orleans and Memphis Districts increased by over 28 and 15 percent, respectively, while the Vicksburg District experienced a loss of 9 percent. Overall, the rural Mississippi Delta suffered the greatest reduction in the total number of persons living in the area. Quitman and Issaquena Counties experienced decreases of 50 and 47 percent, respectively, while the Mississippi study area declined by 20 percent. Population declines occur when the number of persons moving out of an area is greater than the combined number of immigrating residents and the natural population growth (i.e., births and deaths).

TABLE 7-4
HISTORICAL POPULATION STATISTICS

Study Area By District	Population by Year (No.)				
	1960	1970	1980	1990	1960-1990 Growth (%)
CEMVK - Vicksburg District	1,027,276	966,247	996,501	930,291	-9.4
Arkansas Study Area	175,013	175,300	186,088	173,376	-0.9
Louisiana Study Area	283,026	287,980	315,302	300,216	6.1
Mississippi Study Area	569,237	502,967	495,111	456,699	-19.8
CEMVM - Memphis District	1,477,527	1,555,668	1,668,652	1,704,010	15.3
Arkansas Study Area	387,767	368,273	370,903	352,148	-9.2
Illinois Study Area	10,490	8,741	8,840	7,523	-28.3
Kentucky Study Area	11,256	10,183	8,971	8,271	-26.5
Mississippi Study Area	12,891	35,885	53,930	67,910	426.8
Missouri Study Area	242,704	217,343	234,148	228,782	-5.7
Tennessee Study Area	812,419	915,243	991,860	1,039,376	27.9
CEMVN - New Orleans District	1,508,189	1,722,995	1,967,380	1,937,085	28.4
Louisiana Study Area	1,508,189	1,722,995	1,967,380	1,937,085	28.4
TOTAL MRL AREA	4,012,992	4,244,910	4,632,533	4,571,386	13.9

82. Population growth within the MRL region has fluctuated from area to area based on varying factors. In many cases, areas within counties in close proximity to large metropolitan centers have enjoyed substantial population growth. This is evident in reviewing the population trends of counties which encompass Baton Rouge, Monroe, and New Orleans, Louisiana, and Memphis, Tennessee. These centers offer a diversified economic base of jobs, industry, and services which provide for the basic needs of a large population--employment, income, and housing. They also contain extensive transportation networks which accommodate more people and traffic. In contrast, rural areas such as Quitman and Issaquena Counties in Mississippi are less attractive to large numbers of people. These areas are primarily used for activities which require large tracts of land or people looking for quiet, country living.

83. Supplemental attachments for each District study area in the MRL are attached to this Appendix (Attachments 7-A through 7-C). These attachments provide detailed county-level statistics for each of the economic parameters discussed. Population statistics by county are presented in Attachment 7-A (CEMVK, Table 7-A-1 for the Vicksburg District study area); Attachment 7-B (CEMVM, Table 7-B-1 for the Memphis District study area); and Attachment 7-C (CEMVN, Table 7-C-1 for the New Orleans District study area).

Urbanization

84. Although the overall MRL region is predominantly rural, there are 55 cities within the study area that have populations of 10,000 people or greater. Additionally, there were an estimated 109 towns counted with populations between 2,500 and 10,000 people in 1990. Altogether, there are over 164 cities and towns which could be subjected to the trauma and damages incurred by a flood event without the protection afforded by the MRL project. This accounts for over 71 percent of the 1990 study area population. Also, most of these are agrarian communities where the people live a considerable distance from large cities and the services they provide. They would endure additional hardship and inconvenience in obtaining the supplies, services, and emergency relief they would need.

85. The total urban population of the MRL area is depicted in Table 7-5 by District. In addition to these cities, there are also five Metropolitan Statistical Areas (MSA's) designated in the MRL region which include at least some portion of the economic base area. MSA's which are located totally within the economic base area are Baton Rouge, Monroe, and New Orleans, Louisiana; Memphis, Tennessee; and Pine Bluff, Arkansas.

86. The MSA's serve as the major commercial, services, and industrial centers for their regional areas. In addition to their close vicinity to the Mississippi River, each of the major metropolitan centers has international air service and is accessible by multiple interstate and Federal highway systems. Interstate Highways 10, 55, 350, 510, and 610 and U.S. Highways 11, 51, 61, and 90 connect New Orleans to Baton Rouge, Hammond, Metairie, and Slidell. Also, New Orleans has close access to Interstates 12 and 59. Baton Rouge is

TABLE 7-5
LIST OF URBAN AREAS WITH POPULATIONS OF GREATER THAN 2,500 PERSONS IN 1990

CEMVK - Vicksburg District By County/Parish

STATE OF ARKANSAS			
Ashley Crossett Hamburg	**Chicot** Dermott Eudora Lake Village	**Desha** Dumas McGehee	**Drew** Monticello
Jefferson Pine Bluff White Hall			
STATE OF LOUISIANA			
Catahoula Jonesville	**Concordia** Ferriday Vidalia	**East Carroll** Lake Providence	**Franklin** Winnsboro
Madison Tallulah	**Morehouse** Bastrop	**Ouachita** Claiborne Monroe West Monroe	**Richland** Delhi Rayville
STATE OF MISSISSIPPI			
Adams Natchez	**Bolivar** Cleveland Rosedale Shelby	**Coahoma** Clarksdale	**Holmes** Durant
Humphreys Belzoni	**Leflore** Greenwood Itta Bena	**Panola** Batesville Sardis	**Quitman** Marks
Sharkey Rolling Fork	**Sunflower** Drew Indianola	**Tallahatchie** Charleston	**Warren** Vicksburg
Washington Greenville Hollandale Leland	**Yazoo** Yazoo City		

CEMVM - Memphis District By County

STATE OF ARKANSAS			
Arkansas DeWitt Stutttgart	**Craighead** Jonesboro	**Crittenden** Earle Marion West Memphis	**Cross** Wynne
Jackson Newport	**Lee** Marianna	**Mississippi** Blytheville Gosnell Osceola	**Monroe** Brinkley
Phillips Helena West Helena	**Poinsett** Marked Tree Truman	**St. Francis** Forrest City	
STATE OF KENTUCKY		STATE OF MISSISSIPPI	
Fulton Fulton Hickman		**DeSoto** Hernando Olive Branch Horn Lake Southhaven	
STATE OF MISSOURI			
Cape Girardeau Cape Girardeau	**Dunklin** Kennett Maiden	**Mississippi** Charleston East Prairie	**New Madrid** New Madrid Portageville
Pemiscot Caruthersville Hayti	**Scott** Chaffee Sikeston	**Stoddard** Dexter	
STATE OF TENNESSEE			
Dyer Dyersburg Newbern	**Gibson** Humbolt Milan Trenton	**Obion** South Fulton Union City	**Shelby** Bartlett Collierville Germantown Memphis
Tipton Covington	**Weakley** Martin		

CEMVN - New Orleans District By Parish

STATE OF LOUISIANA			
Ascension Donaldsonville Gonzales	**Assumption** Pierre	**East Baton Rouge** Baker Baton Rouge Brownfields Gardere Inniswold Merrydale Monticello Oaks Hill Place Old Jefferson Shenandoah Village St. George Westminster Zachary	**Jefferson** Avondale Bridge City Estelle Gretna Harahan Harvey Jefferson Kenner Marrero Metairie River Ridge Terrytown Timberlane Waggaman Westwego
Avoyelles Bunkie Cottonport Marksville	**Iberville** Plaquemine		
Lafourche Cut Off Galliano Larose Lockport Matthews Raceland Thibodaux	**Plaquemines** Belle Chasse Boothville-Venice Buras-Triumph Empire Port Sulphur		
Orleans New Orleans	**Pointe Coupee** New Roads	**St. Bernard** Arabi Chalmette Poydras Violet	**St. Charles** Boutte Des Allemands Destrehan Hahnville Luling Mimosa Park New Sarpy Norco St. Rose
St. James Lutcher	**St. John the Baptist** Edgard Garyville Laplace Reserve	**St. Landry** Eunice Opelousas	
St. Martin Breaux Bridge St. Martinville	**West Baton Rouge** Port Allen		

accessible via Interstates 10, 12, and 110 and U.S. Highways 61 and 190. Memphis is traversed by Interstates 40, 55, and 240 and U.S. Highway 61, 64, 70, 72, 78, and 79. There is also a proposal underway for an interstate highway system linking the northeastern states to the mid- and southwest. Providing a direct route to Mexico, this transportation corridor would pass through the MRL area. In addition, each of these major cities provides bridge access across the Mississippi River which links the eastern and western regions of the Nation.

87. Other major retail centers located in the MRL area, but inland from the River, are Monroe and Pine Bluff. They are also accessible by interstate and/or Federal highway systems. These transportation corridors provide commercial and private transit connecting various parts of the Nation as well as local and regional areas. In the event of a levee failure, the transportation facilities in all of these locations could be subjected to flooding, structural damage, and/or closed for an extended period of time. Closure of these corridors due to flooding would interfere with the steady flow of trade and commerce on local, regional, and national levels. Not only would this disrupt business activity, it would also create additional expense and inconvenience induced by the rerouting of traffic.

Density

88. Population density for the total MRL area was estimated to be 93 persons per square mile in 1992 (Table 7-6). Other estimates are as follows: 42 persons per square mile in the Vicksburg District study area; 95 persons in the Memphis District; and 215 persons in the New Orleans District. Population density ranged from a low of 5 persons per square mile in Issaquena County, located in the rural Delta of Mississippi, to a high of 1,119 persons in Shelby County--the location of Memphis, Tennessee. Despite the large percentage of the urban population in the MRL area, the number of persons per square mile was generally less than the comparable state densities for each study area. This indicates that the rural population is dispersed over a relatively large geographical area for most of the study area counties.

TABLE 7-6
1992 POPULATION DENSITY

Study Area By District	Persons Per Square Mile (No.)
CEMVK - Vicksburg District	42.0
Arkansas Study Area	38.0
Louisiana Study Area	46.0
Mississippi Study Area	41.0

TABLE 7-6 (Cont)

Study Area By District	Persons Per Square Mile (No.)
CEMVM - Memphis District	95.0
Arkansas Study Area	42.0
Illinois Study Area	37.0
Kentucky Study Area	40.0
Mississippi Study Area	144.0
Missouri Study Area	50.0
CEMVN - New Orleans District	215.0
Louisiana Study Area	215.0
TOTAL MRL AREA	93.0

Population by Age Distribution

89. Population by age distribution for the MRL study area is depicted in Table 7-7. This information provides an understanding of the characteristics of people residing in an area. In the overall study area, the median age is approximately 31 years of age. The largest cohort group is the 25- to 44-year-old age group indicating that the majority of the people who live in the MRL area are working-age people. These statistics parallel national distributions. Also, areas with large population centers tend to have a higher percentage of working age adults than the more rural areas, reflecting the employment opportunities in the large urban areas. The second-most populous group consists of those persons ranging in age from 5 to 17 years old. These data depict families with school-age children.

Housing

90. Another component of the population which can provide insight into significant social developments that influence the economic activity of an area is housing. Data on housing units provide insight into significant aspects of social developments in an area that in turn have an impact on its economic prospects. According to Census statistics depicted in Table 7-8, the total number of households or residences in the MRL area was estimated to be 1.6 million in 1990. This results in about 2.8 persons per household. The number of persons per household has steadily decreased over the years reflecting the same patterns which have occurred across the Nation, which is a trend toward smaller families.

TABLE 7-7
POPULATION BY AGE STATISTICS

Study Area By District	Population By Years of Age Group (No.)								
	Under 5	5-17	18-20	21-24	25-44	45-54	55-64	Over 65	Median Age
CEMVK - Vicksburg District	74,257	214,967	49,753	52,165	254,855	84,485	76,009	123,800	31
Arkansas Study Area	12,609	36,820	9,113	9,617	49,469	17,167	14,500	24,081	32
Louisiana Study Area	23,781	67,240	15,122	17,323	83,464	28,143	26,038	39,105	32
Mississippi Study Area	37,867	110,907	25,518	25,225	121,922	39,175	35,471	60,614	29
CEMVM - Memphis District	131,436	354,986	85,310	100,461	530,404	169,093	124,788	207,380	31
Arkansas Study Area	27,783	93,061	17,256	19,937	99,586	34,797	14,787	44,563	31
Illinois Study Area	542	1,625	286	301	1,896	730	730	1,414	33
Kentucky Study Area	513	1,555	347	380	2,159	802	819	1,687	34
Mississippi Study Area	5,365	14,261	3,124	3,735	22,274	8,285	5,297	5,637	27
Missouri Study Area	16,110	44,927	11,478	12,569	64,143	23,508	20,380	35,772	31
Tennessee Study Area	81,123	199,557	52,819	63,539	340,346	100,971	82,775	118,307	31
CEMVN - New Orleans District	151,325	396,554	96,627	121,605	623,676	186,228	154,247	206,823	31
Louisiana Study Area	151,325	396,554	96,627	121,605	623,676	186,228	154,247	206,823	31
Total MRL Area	357,018	966,507	231,690	274,231	1,408,935	439,806	355,044	538,003	31

TABLE 7-8
1990 GENERAL HOUSING CHARACTERISTICS

Study Area By District	Total Number of Households (No.)	Persons Per Household (No.)	Median Value of Households ($) a/
CEMVK - Vicksburg District	318,802	2.8	47,500
Arkansas Study Area	60,543	2.7	49,100
Louisiana Study Area	105,467	2.8	43,000
Mississippi Study Area	152,792	3.0	49,900
CEMVM - Memphis District	629,817	2.6	67,600
Arkansas Study Area	128,438	2.7	52,000
Illinois Study Area	2,957	2.5	29,900
Kentucky Study Area	3,378	2.4	42,200
Mississippi Study Area	23,273	2.9	77,700
Missouri Study Area	87,944	2.6	49,700
Tennessee Study Area	383,827	2.6	76,800
CEMVN - New Orleans District	696,215	2.9	81,200
Louisiana Study Area	696,215	2.9	81,200
TOTAL MRL AREA	1,644,834	2.8	69,500

a/ Values are expressed in constant 1996 dollars.

91. The median value of a residence in the MRL area was $69,500 in 1990. This represents approximately $114 billion in total residential structure values in the overall economic base area. Median household values in 1990 estimated by study area in each Corps District were as follows--Vicksburg District, $47,500; Memphis District, $67,600; and New Orleans District, $81,200. For the same year, median housing values for the United States were estimated at $98,500. Although the Vicksburg District figure seems low, it should be noted that the Vicksburg portion of the economic base area did not consist of any large urban or metropolitan statistical areas and included a greater number of rural counties. Housing statistics by county are presented in Attachments 7-A through 7-C (Tables 7-A-2 for the Vicksburg District, Table 7-B-2 for the Memphis District, and Table 7-C-2 for the New Orleans District).

92. In discussing impacts from the project, approximately 1.6 million households valued at over $114 billion could directly or indirectly be subjected to flood loss if the main stem levee project were not completed. Crevasses in the existing levee could cause tremendous damage to residences in the MRL area. Secondary damages or costs due to evacuation, reoccupation, cleanup, and other emergency expenses would also add billions of additional dollars to the cost of a major flood.

Number of Automobiles

93. Automobiles indicate another parameter of the social characteristics of the population. Although once an indicator of affluence and mobility, the number of vehicles per household is losing its ability to distinguish significant economic differences. It does, however, serve as a base indicator for the amount of potentially damageable property which exists in a flooded area.

94. Automobile statistics show the average number of vehicles in each household to be fairly consistent throughout the MRL area. Overall, there were an estimated 2.5 million automobiles in the economic base area in 1990, resulting in an average of 1.5 vehicles per household. This parallels the Nation with a total number of automobiles per household of 1.7 in 1990. Automobile statistics for the MRL area are presented in Table 7-9 by District.

TABLE 7-9
1990 AUTOMOBILE STATISTICS

Study Area By District	Automobiles Per Household (No.)	Total Automobiles (No.)
CEMVK - Vicksburg District	1.5	479,379
Arkansas Study Area	1.6	95,686
Louisiana Study Area	1.6	163,361
Mississippi Study Area	1.4	220,332

TABLE 7-9 (Cont)

Study Area By District	Automobiles Per Household (No.)	Total Automobiles (No.)
CEMVM - Memphis District	1.6	1,008,831
Arkansas Study Area	1.5	195,950
Illinois Study Area	1.5	4,537
Kentucky Study Area	1.4	4,913
Mississippi Study Area	1.7	56,479
Missouri Study Area	1.6	142,603
Tennessee Study Area	1.6	604,349
CEMVN - New Orleans District	1.5	1,014,410
Louisiana Study Area	1.5	1,014,410
TOTAL MRL AREA	1.5	2,502,620

ECONOMIC RESOURCES

95. In the analysis of the existing economic conditions of the MRL area, various economic parameters were selected to portray the economic health of the region. Based on their impact on the existing development and future direction of economic activity, the following parameters are discussed--labor force, employment, earnings, income, agricultural activity, and industrial and business activity. An analysis of the trends of some of these indicators provides a view of the region's recent economic performance and, together, these parameters describe the existing economic environment and potential impacts from the project.

LABOR FORCE AND EMPLOYMENT

96. The labor force consists of the working-age subset of the total population of an area. This subset includes those who are 16 years of age or older and are employed or unemployed by civilian or military status. To demonstrate the working environment of the MRL area, labor force

statistics are presented in Table 7-10 by civilian labor force, employment, and unemployment rates. Labor force statistics by county are presented in Attachments 7-A through 7-C (Table 7-A-3, Vicksburg District; Table 7-B-3, Memphis District; and Table 7-C-3, New Orleans District).

TABLE 7-10
1990 LABOR FORCE STATISTICS

Study Area By District	Civilian Labor Force (No.)	Total Employment (No.)	Unemployment Rate (%)
CEMVK - Vicksburg District	371,176	329,523	11.2
Arkansas Study Area	72,221	65,089	9.9
Louisiana Study Area	122,128	109,214	10.6
Mississippi Study Area	176,827	155,220	12.2
CEMVM - Memphis District	801,067	739,942	7.6
Arkansas Study Area	151,228	137,611	9.0
Illinois Study Area	2,800	2,434	13.1
Kentucky Study Area	3,204	2,890	9.8
Mississippi Study Area	35,009	33,128	5.4
Missouri Study Area	103,174	95,101	7.8
Tennessee Study Area	505,652	468,778	7.3
CEMVN - New Orleans District	873,425	791,059	9.4
Louisiana Study Area	873,425	791,059	9.4
TOTAL MRL AREA	2,045,668	1,860,524	9.1

Civilian Labor Force and Unemployment

97. Those persons in the working-age population who are not in the military and who are either employed or unemployed are defined as the civilian labor force. The size of the civilian labor force in the total MRL area increased from 1.5 million people in 1970 to approximately 2.1 million in 1990, an increase of over 38 percent in 20 years. Although labor force statistics show that each District study area experienced overall increases during this period, this is not

indicative of individual county patterns. Labor force declines occurred in 11 of the 85 counties in the economic base area, while increases of greater than 50 percent occurred in 21 counties.

98. Growth in the labor force has also almost doubled the rate of population growth since 1970. While much of the growth can be attributed to increases in the population, a primary influence is the increases in the numbers of the working-age population and the number of women entering the work force. Thus, as discussed earlier in population by age distribution, the working-age portion of the population not only comprised the largest portion of the population, but also consistently experienced increase.

99. Unemployment was determined by the percentage of the civilian labor force that was not employed. Paralleling the labor force, unemployment figures have also increased over the last 20 years. Unemployment in the overall MRL area rose from 5.7 percent in 1970 to 9.1 percent in 1990. Compared to unemployment statistics by District study area, these rates follow closely to the New Orleans District numbers, whereas unemployment trends in the Memphis District have been somewhat lower and the Vicksburg District's unemployment has been higher.

100. In 1990, Jefferson County, Mississippi, experienced the highest unemployment in the economic base area (25.5 percent), followed by East Carroll Parish, Louisiana (24.1 percent). Both of these rural areas are located in the Vicksburg District. In contrast, the lowest unemployment rates in 1990 occurred in DeSoto County, Mississippi (5.4 percent); Cape Girardeau County, Missouri (5.5 percent); and Tipton County, Tennessee (5.5 percent). All of these counties are a part of the Memphis District study area.

Total Employment

101. Total employment in the study area represents the number of wage and salary employees and the number of proprietors. Wage and salary employees include that portion of the working-age population 16 years of age or older who are not in the military and are employed. Total employment numbers reflect the base from which one can evaluate a viable and productive working force of an area. The total number of people employed in the MRL area in 1990 was estimated to be 1.9 million. Of this number, the New Orleans and Memphis Districts comprised 42 and 32 percent, respectively, of the total. Much of this is attributable to the location of metropolitan centers in these areas. The Vicksburg District represented 19 percent of the total employment in 1990.

102. Total employment in the MRL area has grown over 33 percent since 1970, increasing from 1.4 million in 1970 to 1.9 million in 1990. Overall, 66 of the 85 counties have experienced employment increases since 1970. Employment rose in 24 of 36 counties in the Vicksburg District (66 percent of the study area), 25 of 31 counties in the Memphis District (81 percent of the study area), and 17 of 18 counties in the New Orleans District (94 percent of the study area). This indicates a fairly widespread increase throughout the economic base area.

Employment by Industry

103. Employment by industry in the MRL area is presented in Table 7-11 by percent distribution to the total employment for the year 1990. According to the Bureau of the Census, wholesale and retail trade was the prime contributor to the economic base of the area in 1990, comprising 22 percent of the total employment. In 36 counties, it was the number one employer of persons; ranking second, the manufacturing sector consisted of 16 percent of the total employment in the overall area and was the top employer in 41 of the MRL counties. County-level data on employment distributions by industry are presented in Attachments 7-A through 7-C (Table 7-A-4, Vicksburg District; Table 7-B-4, Memphis District; and Table 7-C-4, New Orleans District).

TABLE 7-11
1990 EMPLOYMENT BY INDUSTRY

Study Area By District	Total Employment (No.)	Distribution By Industrial Sector a/ (%)					
		1	2	3	4	5	6
		Ag	Mfg	Trade	FIRE	Health Svc	Public Admin
CEMVK - Vicksburg District	329,523	7.5	18.6	20.1	4.4	8.1	5.2
Arkansas Study Area	65,089	6.6	23.3	18.5	3.7	7.6	6.4
Louisiana Study Area	109,214	6.6	13.8	21.6	5.7	9.7	4.3
Mississippi Study Area	155,220	8.4	20.0	19.8	3.7	7.1	5.4
CEMVM - Memphis District	739,942	3.6	18.9	22.1	5.3	8.8	4.6
Arkansas Study Area	137,611	8.4	22.2	21.1	4.4	7.1	3.7
Illinois Study Area	2,434	7.1	12.2	18.4	3.7	9.0	8.6
Kentucky Study Area	2,890	7.1	34.1	18.2	3.5	5.2	2.8
Mississippi Study Area	33,128	2.0	19.2	25.0	4.4	5.1	3.3
Missouri Study Area	95,101	6.6	22.5	21.2	3.9	8.7	3.1
Tennessee Study Area	468,778	1.7	17.2	22.5	5.9	9.6	5.2
CEMVN - New Orleans District	791,059	1.6	11.6	22.2	6.5	8.8	5.4
Louisiana Study Area	791,059	1.6	11.6	22.2	6.5	8.8	5.4
TOTAL MRL AREA	1,860,524	3.4	15.8	21.8	5.6	8.7	5.1

a/ Based on distributions of those industrial sectors as reported by the U.S. Census Bureau.

NOTE: 1 Agriculture
2 Manufacturing
3 Wholesale and Retail Trade
4 Finance, Insurance, and Real Estate
5 Health Services
6 Public Administration

104. In 1990, agricultural employment represented only 3 percent of the total employment in the overall MRL area, but was the principal employer in seven study area counties. Although employment in the agricultural industry has decreased over the years, much of the industrial base in the area is centered around agriculture and agricultural products. This includes catfish and poultry production; industrial packaging of rice, wheat, and other food crops; farm equipment sales and service; cotton, soybean, and forestry products; and the production of nitrogen fertilizer. Although the farm sector does not account significantly toward the overall area employment, it is the largest employer in many local areas. Overall industry employment figures indicate that, with the exception of the MSA's, the widespread study area has a greater percentage of its population dependent on agriculture-based industries than do their respective states. Thus, agricultural flooding could have a greater effect on the employment numbers in these areas in comparison to other parts of the study area.

EARNINGS AND INCOME

105. The economy of the MRL area is explained in terms of earnings and income in the following paragraphs. The sum of wages and salary disbursements, other labor income such as commissions and tips, and proprietor's income is classified as earnings. Income comprises earnings plus property income and government or business transfer payments.

Earnings

106. One way the economy of an area is quantified is through the total earnings generated. The total earnings in the MRL area were estimated to be $64.4 billion in 1990, with the New Orleans District study area representing 46 percent of the total; the Memphis District, 39 percent; and the Vicksburg District, 15 percent. Orleans Parish alone, which contains the city of New Orleans, comprised 16 percent of the total earnings in 1990. These values, expressed in constant 1996 dollars, include the total of all wages, salary disbursements, and other labor and proprietors' income.

107. Total earnings by industry are expressed in constant 1996 dollars for the year 1990 (Table 7-12). The major sectors contributing toward total earnings were the services, manufacturing, retail trade, government, and farming industries. Although farming and forestry have historically been major enterprises in the past, services and manufacturing have become increasingly important to the economy over the last several decades. Much of this is due to increased efforts toward mechanization and industrialization of production processes and the infiltration of a diversity of industries into the region.

108. According to estimates reported by the U.S. Bureau of Census, distributions of earnings by industry are somewhat similar to the distributions of employment by industry discussed previously. Services and manufacturing were the leading contributors to earnings in the overall

TABLE 7-12
1990 EARNINGS BY INDUSTRY

Study Area By District	Total Earnings a/ ($)	Distribution By Industrial Sector b/ (%)						
		1	2	3	4	5	6	7
		Mfg	Retail Trade	FIRE	Services	Ag	Govt	Other
CEMVK - Vicksburg District	9,636	20.4	9.2	3.9	19.3	8.8	18.2	20.2
Arkansas Study Area	2,046	26.5	7.9	3.1	16.5	8.0	17.9	19.8
Louisiana Study Area	2,998	16.4	9.7	5.7	24.0	8.1	16.3	20.5
Mississippi Study Area	4,592	20.2	9.5	3.0	17.6	9.7	19.6	25.5
CEMVM - Memphis District	25,247	18.7	9.8	5.1	22.4	2.9	16.2	25.5
Arkansas Study Area	3,642	23.2	4.5	3.3	16.1	11.2	16.4	19.9
Illinois Study Area	67	11.4	13.0	2.4	12.4	14.5	30.7	62.8
Kentucky Study Area	82	28.5	9.2	3.2	14.2	6.6	19.0	50.9
Mississippi Study Area	633	37.5	10.4	c/	17.4	1.1	25.9	21.2
Missouri Study Area	2,548	20.6	9.7	3.3	22.3	7.4	13.2	22.8
Tennessee Study Area	18,275	16.9	9.3	5.9	23.9	0.5	16.2	26.8
CEMVN - New Orleans District	29,555	14.0	9.0	5.7	27.5	0.6	15.6	27.6
Louisiana Study Area	29,555	14.0	9.0	5.7	27.5	0.6	15.6	27.6
TOTAL MRL AREA	64,438	16.8	9.3	5.2	24.3	2.7	16.2	25.6

a/ Values expressed in millions of constant 1996 dollars.
b/ Based on distributions of those industrial sectors as reported by the U.S. Census Bureau.
c/ Data are not shown to avoid disclosure of individual firms.

NOTE:
1 Manufacturing
2 Retail trade
3 Finance, insurance, and real estate
4 Services
5 Agriculture
6 Government
7 Agricultural services, forestry, and fisheries; transportation and public utilities; wholesale trade; mining; construction; and other miscellaneous services industries

MRL area in 1990, comprising 24.3 and 16.8 percent, respectively. However, a true scenario cannot be illustrated since there were incomplete data for seven of the counties in the study area. Census policy prohibits disclosure of financial information that could reasonably be linked to the performance of individual businesses. Earnings by industry statistics by county are presented in Tables 7-A-5, 7-B-5, and 7-C-5.

109. Although there are incomplete data for some of the counties in the MRL area due to Census disclosure policies, percentages for services are deemed to be fairly indicative of existing earnings patterns. The services sector has emerged as a major contributor to the economy of the overall area. In 1990, services was the No. 1 contributor to 14 study area counties and ranked second in 23 counties. Manufacturing earnings, representing 16.8 percent of the total earnings in 1990, was the major contributor in 34 counties and ranked second in 18 counties.

110. The government, trade, and farm sectors have also played significant roles in local economies of the economic base area. In 1990, government comprised 16.2 percent of total earnings and ranked first in 18 MRL counties. Retail trade accounted for 9.3 percent of the total earnings in 1990, and earnings from agriculture were estimated to be 2.7 percent. Although the distribution of farm earnings seems low, it was the major contributor in 16 MRL counties and ranked second in 6 counties.

Personal and Per Capita Income

111. Total personal income (PI), the principal component of gross national product, is an excellent indicator of economic activity within an area. The total personal income of the total MRL area totaled over $77.9 billion in 1989 (in constant 1996 dollars) (Table 7-13). On a per capita basis, this results in an income of approximately $17,000 per person.

TABLE 7-13
1989 PERSONAL AND PER CAPITA INCOME STATISTICS

Study Area By District	Total Personal Income ($) a/	Total Per Capita Income ($) a/ b/
CEMVK - Vicksburg District	9,923	10,700
Arkansas Study Area	1,997	11,500
Louisiana Study Area	3,419	11,400
Mississippi Study Area	4,507	9,900

TABLE 7-13 (Cont)

Study Area By District	Total Personal Income ($) a/	Total Per Capita Income ($) a/ b/
CEMVM - Memphis District	24,456	14,400
Arkansas Study Area	3,982	11,300
Illinois Study Area	79	10,600
Kentucky Study Area	101	12,200
Mississippi Study Area	1,058	15,600
Missouri Study Area	2,815	12,300
Tennessee Study Area	16,421	15,800
CEMVN - New Orleans District	43,479	22,400
Louisiana Study Area	43,479	22,400
TOTAL MRL AREA	77,858	17,000

a/ Expressed in millions of constant 1996 dollars.
b/ PCI is derived by dividing personal income by population.

112. By District study area, total PI estimates in 1989 were as follows: Vicksburg District, $9.9 billion; Memphis District, $24.5 billion; and New Orleans District, $43.5 billion. With 18 and 13 percent, respectively, of the total PI, Shelby County in Tennessee and Orleans Parish in Louisiana led the MRL area in PI with an estimated $13.7 and $10.3 billion, respectively, in 1989.

113. The PCI, which is used as a measure of the relative support the economy provides for the population of an area, was estimated to be $17,000 in the total MRL area in 1989. The New Orleans District represented the highest PCI in the area with $22,400 in 1989. This is mostly due to the growth of suburbanized areas near the New Orleans MSA in this region. For example, St. Charles Parish, located adjacent to New Orleans, represented the highest PCI reported in the MRL area ($44,000). In comparison, the PCI's for the Memphis and Vicksburg Districts were estimated to be $14,400 and $10,700, respectively, in 1989. These figures correspond to an estimated PCI of $18,700 for the United States for the same year. Personal income and PCI by county are presented in Tables 7-A-6, 7-B-6, and 7-C-6.

114. Large metropolitan areas have a major influence on the amount of income generated in an area. Although the large cities experience a higher cost of living, they contain and support a highly diversified base of well-paying capital intensive industries, and their wage rates provide a higher standard of living than is typical in small, southern communities. Thus, those people who live in smaller communities and areas within close proximity to the MSA's, and especially near Baton Rouge, Memphis, and New Orleans, will reap some of the benefits these cities have to offer.

115. With the exception of the MSA's, the PCI generated in the MRL area is slightly below the national average (see Table 7-13). Those who work and live in the areas that would be directly affected by floodwaters rely on the protection afforded by the levee project. The disruption that occurs from a flood is not only an inconvenience, but a matter of livelihood for many of them.

AGRICULTURAL ACTIVITY

116. Throughout history, favorable agricultural characteristics have been significant factors in the development of land use patterns in the MRL area. The land around the Mississippi River is rich with some of the most fertile soils in the world for growing crops. Each year the region supplies substantial contributions toward the Nation's food and fiber requirements. In 1992, the economic base area contributed 17.8 million acres of land toward the production of agricultural goods utilized worldwide. Among the major agricultural commodities supplied by the region are cotton, soybeans, rice, corn, and catfish. General agricultural characteristics for the year 1992 are displayed in Table 7-14.

TABLE 7-14
1992 GENERAL AGRICULTURAL STATISTICS

Study Area By District	Total Number of Farms (No.)	Average Size of Farms (Acres)	Total Land in Farms (Acres in 000)	Total Value of Farm Products Sold ($) a/
CEMVK - Vicksburg District	13,124	598	7,844	2,112.6
Arkansas Study Area	2,336	588	1,375	370.2
Louisiana Study Area	4,893	460	2,249	580.5
Mississippi Study Area	5,895	716	4,220	1,161.9

TABLE 7-14 (Cont)

Study Area By District	Total Number of Farms (No.)	Average Size of Farms (Acres)	Total Land in Farms (Acres in 000)	Total Value of Farm Products Sold ($) a/
CEMVM - Memphis District	16,010	523	8,371	2,287.7
Arkansas Study Area	5,317	783	4,164	1,188.9
Illinois Study Area	218	378	82	18.5
Kentucky Study Area	164	590	97	24.4
Mississippi Study Area	488	286	140	28.7
Missouri Study Area	5,107	455	2,322	661.3
Tennessee Study Area	4,716	322	1,566	365.9
CEMVN - New Orleans District	5,115	301	1,540	526.2
Louisiana Study Area	5,115	301	1,540	526.2
TOTAL MRL AREA	34,249	518	17,755	4,926.4

a/ Expressed in millions of constant 1996 dollars.

117. The Mississippi River has been the basis for the economies which have developed along its banks. Failure of the Mississippi River levees during the time of a major flood event would allow destruction of crops and related agricultural industries in this region. Not only would this result in massive damages regionwide, but would also deliver a devastating blow to people dependent on these activities for their livelihood. The economies of the region are reliant, not only on the waters of the Mississippi River itself, but on the agricultural and industrial bases which have developed as a result of the River.

118. Historically, agricultural resources have been important to the economy of the region. However, along with industrial expansion and the increased commercialization and mechanization of farms, farming operations have followed a national trend of consolidation. Today, there are fewer farms with larger acreages. In 1992 there were 34,249 farms in the MRL area comprising a total of 17.8 million acres. This results in an average size per farm of 518 acres. In comparison, there were 44,030 farms totaling 19.1 million acres in 1978 averaging 434 acres per farm. These numbers reflect a 22 percent decrease in the number of farms, a 7 percent decrease in the total land in farms, and a 19 percent increase in farm size. Each District study area also followed this same trend. However, the Arkansas, Illinois, and Missouri study areas showed a slight increase in total acreage in farms, as did nine of their contributing counties.

Value of Agricultural Products Sold

119. Total sales from agricultural products (presented in constant 1996 dollars) are depicted in Table 7-14 for 1992. The total value of farm products sold was valued at $4.9 billion in 1992, a 23 percent decrease over the $6.4 billion reported in 1978. The Memphis District study area represented 46 percent of the sales from farm products sold for the MRL area in 1992 followed closely by the Vicksburg District with 43 percent. The primary counties which have contributed to and benefited economically from agricultural production (as reflected by the 1992 statistics) are Arkansas, Craighead, Mississippi, and Poinsett Counties in Arkansas; St. Bernard Parish in Louisiana; Bolivar, Humphreys, Sunflower, and Washington Counties in Mississippi; and New Madrid and Stoddard Counties in Missouri. As a major contributor to the economies of many MRL counties, agricultural production, especially in the rich Delta of the Mississippi River, remains a viable industry in the region. General agricultural statistics by county are presented in Tables 7-A-7, 7-B-7, and 7-C-7.

120. Farm products sold reported by state and the Nation (expressed in constant 1996 dollars) are as follows for 1992: Arkansas, $4.6 billion; Illinois, $8.9 billion; Kentucky, $2.9 billion; Louisiana, $1.9 billion; Mississippi, $2.6 billion; Missouri, $5.1 billion; Tennessee, $2.3 billion; and the United States, $190.0 billion.

INDUSTRY AND BUSINESS

121. The "Sunbelt movement" of the 1970's helped stimulate the economy of the Mississippi River Delta regions by creating more industry and jobs, thereby increasing total employment. This era resulted in the emergence of the manufacturing, trade, and services industries as significant contributors to local economies. Discussed in the following paragraphs, these sectors represent the economic indicators for industrial and business activity in the MRL area.

122. Tables 7-15 and 7-16 include the number of establishments and business sales volume (expressed in constant 1996 dollars) for manufacturing, retail and wholesale trade, and selected services for the years 1977 and 1992, respectively. The 1977 statistics by county are presented in Tables 7-A-8A, 7-B-8A, and 7-C-8A for each District area. The 1992 statistics are presented in Tables 7-A-8B, 7-B-8B, and 7-C-8B. These figures reveal the broad industrial base and potential business volume that exists. Overall, there were an estimated total of 78,610 business and industrial establishments located in the MRL area in 1992 with a total business sales volume of approximately $112 billion (in constant 1996 dollars). These industries have emerged as the major contributors to many of the study area counties.

Manufacturing

123. With 6,600 manufacturing establishments reported in 1992, manufacturing activity has contributed significantly to the well-diversified industrial base in the MRL area. Of these, the Vicksburg District study area accounted for 2,850 manufacturing firms; Memphis District, 2,030;

TABLE 7-15
1977 INDUSTRIAL AND BUSINESS ACTIVITY

Study Area By District	Manufacturing		Wholesale Trade		Retail Trade		Selected Services	
	Total Establishments (No.)	Value Added By Mfg ($) a/	Total Establishments (No.)	Sales ($) a/	Total Establishments (No.)	Sales ($) a/	Total Establishments (No.)	Sales Receipts ($) a/
CEMVK - Vicksburg District	2,850	3,281.9	1,553	7,711.3	8,695	6,089.2	5,321	929.8
Arkansas Study Area	243	761.3	270	1,102.8	1,627	1,160.3	1,094	125.9
Louisiana Study Area	2,108	659.2	502	2,471.1	2,655	2,133.0	1,730	279.9
Mississippi Study Area	499	1,861.4	781	4,137.4	4,413	2,795.9	2,497	524.0
CEMVM - Memphis District	2,030	8,770.6	3,339	41,093.9	13,468	11,977.0	10,994	2,188.8
Arkansas Study Area	412	1,399.5	618	2,288.9	3,864	2,566.1	2,295	304.8
Illinois Study Area	7	5.6	9	51.0	35	10.2	26	2.6
Kentucky Study Area	9	20.5	24	140.8	153	100.7	72	6.9
Mississippi Study Area	62	161.8	39	285.7	309	210.5	234	21.0
Missouri Study Area	261	682.1	479	2,259.5	2,036	1,388.7	1,542	166.9
Tennessee Study Area	1,279	6,501.1	2,170	36,068.0	7,071	7,700.8	6,825	1,686.6
CEMVN - New Orleans District	1,720	14,117.0	3,363	27,816.9	13,939	16,163.8	13,713	4,249.2
Louisiana Study Area	1,720	14,117.0	3,363	27,816.9	13,939	16,163.8	13,713	4,249.2
TOTAL MRL AREA	6,600	26,169.5	8,255	76,622.1	36,102	34,230.0	30,028	7,367.8

a/ Values expressed in millions of constant 1996 dollars.

TABLE 7-16
1992 INDUSTRIAL AND BUSINESS ACTIVITY

Study Area By District	Manufacturing		Wholesale Trade		Retail Trade		Selected Services	
	Total Establishments (No.)	Value Added By Mfg ($) a/	Total Establishments (No.)	Sales ($) a/	Total Establishments (No.)	Sales ($) a/	Total Establishments (No.)	Sales Receipts ($) a/
CEMVK - Vicksburg District	957	3,583.9	1,497	6,169.7	9,686	5,967.7	4,138	1,546.2
Arkansas Study Area	199	677.7	254	642.8	1,815	1,083.2	723	251.4
Louisiana Study Area	286	833.0	521	2,191.7	3,118	2,157.0	1,508	690.4
Mississippi Study Area	472	2,073.2	722	3,335.2	4,753	2,727.5	1,907	604.4
CEMVM - Memphis District	2,195	12,407.8	3,651	10,550.5	10,084	14,067.1	10,162	6,871.2
Arkansas Study Area	413	2,268.7	566	1,865.2	2,219	2,467.2	1,677	744.1
Illinois Study Area	2	b/	8	146.7	40	16.9	16	3.8
Kentucky Study Area	13	58.0	20	80.5	73	65.6	38	19.2
Mississippi Study Area	138	681.3	75	1,381.5	314	442.5	283	143.3
Missouri Study Area	308	1,334.4	561	2,565.9	1,604	1,825.4	1,272	545.1
Tennessee Study Area	1,321	8,065.4	2,421	4,510.7	5,834	9,249.5	6,876	5,415.7
CEMVN - New Orleans District	1,570	12,391.4	3,704	14,845.9	17,976	15,384.6	12,990	8,451.0
Louisiana Study Area	1,570	12,391.4	3,704	14,845.9	17,976	15,384.6	12,990	8,451.0
TOTAL MRL AREA	4,722	28,383.1	8,852	31,566.1	37,746	35,419.4	27,290	16,868.4

a/ Values expressed in millions of constant 1996 dollars.
b/ Data are not shown to avoid disclosure of individual firms.

and New Orleans District, 1,720. As expected, the majority of the manufacturing activity in the region hubs around the larger metropolitan centers and urbanized areas--Baton Rouge, Memphis, Monroe, New Orleans, and Pine Bluff.

124. Value added by manufacturing is the principal measure reflecting the value of industrial production of an area. The value added is derived by subtracting the cost of materials and services from the value of shipments, and thus, constitutes a measure of the economic worth of the manufacturing activity based on production. The value added by manufacturing was estimated to be $28.4 billion in 1992 for the total MRL area. This is an 8 percent increase over the value reported for 1977 of $26.2 billion. Both the Memphis and New Orleans District study areas accounted for 44 percent of the value added by manufacturing in 1992. The Vicksburg District comprised 12 percent. In a comparison of individual counties reported, Shelby County contributed the most (21 percent) followed by East Baton Rouge and St. Charles Parishes (8 percent each). Issaquena County in the Mississippi Delta of the Vicksburg District accounted for the least value added by manufacturing.

Retail and Wholesale Trade

125. Retail and wholesale trade represents the economic and business activity in the area based on the sales volume of merchandise. Retail and wholesale trade together accounted for 22 percent of the total employment in the MRL area in 1990. In addition, earnings from retail trade comprised over 9 percent of total earnings in the economic base area. Wholesale trade earnings were not available due to data being withheld to avoid disclosure of individual reporting units.

126. Retail sales, defined as the total of merchandise sold plus receipts from repairs and other services to customers, increased from $34.2 billion in 1977 to $35.4 billion in 1992, an increase of about 3 percent. During the same time, the number of retail establishments increased by over 1,600 firms (see Tables 7-15 and 7-16).

127. Statistics indicate the retail trade to be fairly evenly distributed between the Memphis and New Orleans District study areas with 43 and 40 percent, respectively, of the total retail sales in 1992. The Vicksburg District study area comprised 17 percent of total sales for the same year.

128. Based on 1992 county-level statistics (Tables 7-A-8B, 7-B-8B, and 7-C-8B), the primary contributors in each District to total MRL retail sales were as follows, by distribution: Shelby County (Memphis District), 23 percent; Jefferson, Orleans, and East Baton Rouge Parishes (New Orleans District), 14, 11, and 10 percent, respectively; and Ouachita Parish and Jefferson County (Vicksburg District), 4 and 2 percent, respectively. Altogether, these predominantly urban counties comprised over one-half of the total retail establishments in the MRL area in 1992. These statistics indicate that the majority of the commercial activity occurs near the

larger metropolitan centers of Memphis, New Orleans, Baton Rouge, Monroe, and Pine Bluff. Other areas in the region which have emerged as retail centers for their local areas include Craighead (Jonesboro) and Mississippi (Blytheville) Counties in Arkansas; Ascension (Gonzales), Lafourche (Thibodeaux), St. Bernard (Chalmette), and St. Landry (Opelousas) Parishes in Louisiana; Warren (Vicksburg) and Washington (Greenville) Counties in Mississippi; Cape Girardeau County (Cape Girardeau) in Missouri; and Dyer County (Dyersburg) in Tennessee.

129. Wholesale trade, which has declined somewhat over the period, is defined as the sale of merchandise of establishments with one or more paid employees, primarily engaged in selling merchandise to retailers; institutional, industrial, commercial, and professional users or other whole sellers; or in negotiating as agents in buying merchandise for or selling merchandise to such persons or companies. Although the number of wholesale establishments has continued to grow in the MRL area, wholesale sales have decreased significantly since 1977. Wholesale trade dropped from approximately $76.6 billion in 1977 to $31.6 billion in 1992, a 59 percent decline. During the same period, the number of establishments increased by almost 600 firms. The New Orleans District area was the major contributor to wholesale trade in 1992, comprising 57 percent of the total MRL area.

Selected Services

130. Selected services, which represent service industries such as hotels and motels; repair services; and dental, medical, and legal services, are also indicators of business activity. Selected services ranked first in the MRL area in total earnings in 1990 accounting for 18 percent of the total. As with other business activity in the economic base area, major service industries are located near the large metropolitan areas--New Orleans, Memphis, Baton Rouge, Pine Bluff, and Monroe. Shelby County was the single largest contributor to sales receipts in services with 30 percent in 1992 followed by Orleans Parish with 19 percent.

131. Selected services in the MRL area have flourished over the last several decades. Statistics (Tables 7-15 and 7-16) indicate a substantial increase in sales receipts of 129 percent since 1977. In 1977, receipts from selected services were estimated at $7.4 billion increasing to $16.9 billion in 1992. However, during the same period, the number of services establishments decreased by over 2,700 businesses. With over one-half the total number of services establishments in the MRL area, the New Orleans District study area is again the largest contributor (50 percent) due to the services provided by the large metropolitan centers. The mostly rural Vicksburg District accounted for only 9 percent of the sales from selected services in 1992.

FINANCIAL STATISTICS

132. Statistics for local government finances and financial institutions located in the MRL area are discussed in the following paragraphs. These statistics may be seen as indicators of the financial health of the region.

Local Government Finance

133. The balance sheet for local governments, depending on mandated expenditures, reflects the financial health of the local economy. Growing revenues generally mean a thriving economy, and growing expenditures coupled with declining revenues can mean an economy in distress. Financial statistics for local governments in the overall MRL area are presented in Table 7-17, expressed in constant 1996 dollars. In 1992, total general revenues were estimated to be $8.1 billion as compared to $8.0 billion for direct general expenditures. The figures indicate that, for that year, the local governments covered all costs of operations from general revenues. However, on an individual basis, 46 of the 85 MRL counties expended more than their revenues for 1992. This is a trend that occurs frequently in local governments nationwide. Local government statistics by county are presented in Tables 7-A-9, 7-B-9, and 7-C-9.

TABLE 7-17
1992 LOCAL GOVERNMENT FINANCIAL STATISTICS

Study Area By District	Total General Revenue ($) a/	Total General Expenditure ($) a/
CEMVK - Vicksburg District	1,683.3	1,670.9
Arkansas Study Area	279.5	283.3
Louisiana Study Area	507.6	511.2
Mississippi Study Area	896.2	876.4
CEMVM - Memphis District	2,368.9	2,424.9
Arkansas Study Area	386.8	390.1
Illinois Study Area	9.9	9.9
Kentucky Study Area	10.7	13.7
Mississippi Study Area	57.3	52.3
Missouri Study Area	240.5	249.9
Tennessee Study Area	1,663.7	1,709.0
CEMVN - New Orleans District	4,032.1	3,914.1
Louisiana Study Area	4,032.1	3,914.1
TOTAL MRL AREA	8,084.3	8,009.9

a/ Expressed in millions of constant 1996 dollars.

Banks and Savings Institutions

134. Statistics for banks and savings institutions in the MRL area are presented in Table 7-18 by District. In 1992, there were a total of 1,415 bank offices and 163 savings institutions located in the economic base area. The majority of the financial institutions are located in the major retail centers of Memphis, New Orleans, and Baton Rouge. Total bank deposits, expressed in constant 1996 dollars, totaled $46.7 billion as of June 1992 while savings were estimated to be $7.2 billion. Banks and savings statistics for the MRL area by county are presented in Tables 7-A-10, 7-B-10, and 7-C-10.

TABLE 7-18
1992 BANKS AND SAVINGS STATISTICS a/

Study Area By District	Banks		Savings Institutions	
	Total Offices (No.)	Total Deposits ($) b/	Total Offices (No.)	Total Deposits ($) b/
CEMVK - Vicksburg District	336	8,734.4	20	411.9
Arkansas Study Area	64	1,728.6	1	19.9
Louisiana Study Area	97	3,148.1	3	97.4
Mississippi Study Area	175	3,857.7	16	294.6
CEMVM - Memphis District	574	18,077.3	54	2,504.8
Arkansas Study Area	144	3,319.8	14	364.8
Illinois Study Area	4	45.3	0	0.0
Kentucky Study Area	6	162.3	2	33.0
Mississippi Study Area	27	418.5	2	36.1
Missouri Study Area	91	2,806.4	13	297.0
Tennessee Study Area	302	11,325.0	23	1,773.9
CEMVN - New Orleans District	505	19,935.7	89	4,278.5
Louisiana Study Area	505	19,935.7	89	4,278.5
TOTAL MRL AREA	1,415	46,747.4	163	7,195.2

a/ SAIF-insured, OTS-regulated savings institutions.
b/ Expressed in millions of constant 1996 dollars.

FUTURE SOCIOECONOMIC CONDITIONS

135. This section discusses the future economic conditions expected to occur in the economic base area to the year 2040. Based on the current economic environment, three major economic indicators were projected to give an idea of the direction of future growth in the MRL area--population, employment, and income. Projections are presented separately for each parameter by overall and District study area.

METHODOLOGY

136. Projections were made based on factors derived from Regional Projections to 2040, Volume 1: States, published by the Bureau of Economic Analysis in 1990. Growth factors determined from each of the seven states in the MRL area were applied to each District study area by state to develop future estimates of population, employment, and income. These projections should not be interpreted as being precise values for future years. Rather, they should be used as indicators of the direction and relative magnitude of economic activity that may be expected to occur over the 50-year growth period in the MRL area.

PROJECTIONS BY ECONOMIC PARAMETER

Population

137. Population growth is a direct reflection of the economic growth of an area; thus, an understanding of the economic growth potential is essential in projecting population growth. Population levels are good indicators of the size of an urban area and its land use needs such as residential, commercial, and other urban uses. Population statistics are also the basis for many other economic parameters such as PCI, persons per household, population density, etc.

138. Population projections are presented in Table 7-19 for existing (1990) and future conditions to the year 2040 for the MRL area. Population in the overall area is projected to increase from 4.6 million people in 1990 to approximately 4.9 million by the year 2040, representing an increase of almost 7.3 percent. While the trend for the overall MRL area is projected for low growth over the 50-year period, some local areas are expected to experience a slight decrease in population over this period.

139. The majority of the population increase in the MRL area (14 percent) is expected to occur in the Memphis District study area with the Tennessee portion projected to increase by almost 200,000 persons over the next 50 years. Other areas expected to have higher than average population growth are the Vicksburg District (Arkansas) and Memphis District (Illinois) study areas which are expected to grow by approximately 16 percent each, and the Memphis District (Missouri) study area which is projected to increase by 15 percent. The lowest growth is projected in the Louisiana study areas of both the New Orleans and Vicksburg Districts. The number of persons residing in these regions is expected to remain close to the same.

TABLE 7-19
PROJECTED POPULATION STATISTICS

Study Area By District	Population by Year (No.)						
	Existing	Projected					1990-2040 Growth (%)
	1990	2000	2010	2020	2030	2040	
CEMVK - Vicksburg District	**930,200**	**951,000**	**971,000**	**1,001,600**	**1,006,400**	**1,012,400**	**8.8**
Arkansas Study Area	173,300	180,500	186,700	195,000	197,000	200,300	15.5
Louisiana Study Area	300,200	299,500	300,600	305,500	304,000	302,500	0.8
Mississippi Study Area	456,700	471,000	483,700	501,100	505,400	509,600	11.6
CEMVM - Memphis District	**1,704,000**	**1,774,400**	**1,859,400**	**1,909,700**	**1,918,700**	**1,938,200**	**13.7**
Arkansas Study Area	352,100	366,600	379,300	367,700	357,000	356,900	1.4
Illinois Study Area	7,500	7,900	8,200	8,500	8,600	8,700	16.0
Kentucky Study Area	8,300	8,500	8,800	9,100	9,200	9,300	12.1
Mississippi Study Area	67,900	70,000	71,900	74,500	75,100	75,800	11.6
Missouri Study Area	228,800	239,400	248,800	258,100	260,700	263,200	15.0
Tennessee Study Area	1,039,400	1,082,000	1,142,400	1,191,800	1,208,100	1,224,300	17.8
CEMVN - New Orleans District	**1,937,100**	**1,932,300**	**1,939,800**	**1,971,000**	**1,961,600**	**1,952,100**	**0.8**
Louisiana Study Area	1,937,100	1,932,300	1,939,800	1,971,000	1,961,600	1,952,100	0.8
TOTAL MRL AREA	**4,571,300**	**4,657,700**	**4,770,200**	**4,882,300**	**4,886,700**	**4,902,700**	**7.3**

Employment

140. Projections of total employment are presented in Table 7-20 for the MRL area. Employment projections indicate growth to be somewhat sluggish over the next 50 years in the economic base area. This component of the economic sector is only projected to increase by 30,000 persons, from approximately 1,860,500 in 1990 to 1,890,600 in 2040, or 2 percent. This slow growth seems to be due to expected declines in Louisiana portions of the MRL area over the next 50 years. Previously, the New Orleans District has been one of the number one contributors to various sectors of the economy. Losses in this region have a significant impact on the surrounding economies in the MRL area.

141. Total employment is expected to increase, but at a low rate. Projection statistics indicate total employment in the Memphis District to increase over 9 percent by the year 2040 with the Tennessee and Illinois study areas expected to gain by 12 and 8 percent, respectively. Additionally, aside from Louisiana, total employment in many rural study areas is projected to grow at a modest rate.

Income

142. Income forecasts, which are presented in Table 7-21 for the MRL area, show PCI to increase substantially in all areas of the economic base area over the next 50 years. Overall, PCI is projected to increase from $17,000 in 1989 to $25,300 by 2040, or approximately 49 percent. The New Orleans area is expected to experience the most gain in PCI over the next several decades (59 percent). Income values in Table 7-21 are expressed in constant 1996 dollars.

TABLE 7-20
PROJECTED EMPLOYMENT STATISTICS

Study Area By District	Total Employment by Year (No.)						
	Existing	Projected					1990-2040 Growth (%)
	1990	2000	2010	2020	2030	2040	
CEMVK - Vicksburg District	**329,500**	**354,300**	**362,300**	**351,100**	**342,200**	**333,200**	**1.1**
Arkansas Study Area	65,100	71,100	73,300	71,400	69,800	68,200	4.8
Louisiana Study Area	109,200	114,600	115,300	110,500	106,900	103,300	-5.4
Mississippi Study Area	155,200	168,600	173,700	169,200	165,500	161,700	4.2
CEMVM - Memphis District	**739,900**	**822,200**	**857,200**	**840,000**	**824,600**	**809,200**	**9.4**
Arkansas Study Area	137,600	150,300	155,000	151,000	147,600	144,300	4.9
Illinois Study Area	2,400	2,700	2,800	2,700	2,700	2,600	8.3
Kentucky Study Area	2,900	3,100	3,200	3,200	3,100	3,000	3.5
Mississippi Study Area	33,100	36,000	37,100	36,100	35,300	34,500	4.2
Missouri Study Area	95,100	103,800	107,500	104,900	102,700	100,500	5.7
Tennessee Study Area	468,800	526,300	551,600	542,100	533,200	524,300	11.8
CEMVN - New Orleans District	**791,100**	**830,400**	**835,100**	**800,500**	**774,400**	**748,200**	**-5.4**
Louisiana Study Area	791,100	830,400	835,100	800,500	774,400	748,200	-5.4
TOTAL MRL AREA	**1,860,500**	**2,006,900**	**2,054,600**	**1,991,600**	**1,941,200**	**1,890,600**	**1.6**

TABLE 7-21
PROJECTED PER CAPITA INCOME STATISTICS

Study Area By District	Per Capita Income ($) a/						
	Existing	Projected					1990-2040 Growth (%)
	1989	2000	2010	2020	2030	2040	
CEMVK - Vicksburg District	**10,700**	**12,000**	**13,000**	**13,500**	**14,600**	**15,700**	**46.7**
Arkansas Study Area	11,500	12,700	13,500	13,800	14,800	15,700	36.5
Louisiana Study Area	11,400	13,100	14,400	15,200	16,600	18,100	58.8
Mississippi Study Area	9,900	11,000	11,900	12,300	13,300	14,300	44.4
CEMVM - Memphis District	**14,400**	**15,800**	**16,600**	**17,100**	**18,500**	**19,900**	**38.2**
Arkansas Study Area	11,300	12,500	13,200	14,600	16,300	17,600	55.8
Illinois Study Area	10,600	11,200	11,600	11,200	12,300	13,500	27.4
Kentucky Study Area	12,200	13,600	14,500	15,000	16,100	17,300	41.8
Mississippi Study Area	15,600	17,400	18,800	19,400	21,000	22,600	44.9
Missouri Study Area	12,300	13,400	14,200	13,600	15,100	16,600	35.0
Tennessee Study Area	15,800	17,400	18,100	18,500	19,800	21,100	33.5
CEMVN - New Orleans District	**22,400**	**25,800**	**28,400**	**29,900**	**32,800**	**35,700**	**59.4**
Louisiana Study Area	22,400	25,800	28,400	29,900	32,800	35,700	59.4
TOTAL MRL AREA	**17,000**	**19,200**	**20,600**	**21,500**	**23,400**	**25,300**	**48.8**

a/ Values are expressed in constant 1996 dollars.

ATTACHMENT 7-A
STATISTICS BY COUNTY AND PARISH
VICKSBURG DISTRICT - CEMVK

TABLE 7-A-1
HISTORICAL POPULATION STATISTICS FOR THE VICKSBURG DISTRICT
MRL STUDY AREA

BY COUNTY/PARISH AND STATE	TOTAL POPULATION BY YEAR (No.)				
	1960	1970	1980	1990	OVERALL GROWTH (%)
STATE OF ARKANSAS	1,786,272	1,923,322	2,286,357	2,350,725	31.6
Ashley	24,220	24,976	26,538	24,319	0.4
Chicot	18,990	18,164	17,793	15,713	(17.3)
Desha	20,770	18,761	19,760	16,798	(19.1)
Drew	15,213	15,157	17,910	17,369	14.2
Jefferson	81,373	85,329	90,718	85,487	5.1
Lincoln	14,447	12,913	13,369	13,690	(5.2)
ARKANSAS COUNTY TOTAL	175,013	175,300	186,088	173,376	(0.9)
STATE OF LOUISIANA	3,257,022	3,644,637	4206116	4,219,973	29.6
Caldwell	9,004	9,354	10,761	9,810	9.0
Catahoula	11,421	11,769	12,287	11,065	(3.1)
Concordia	20,467	22,578	22,981	20,828	1.8
East Carroll	14,433	12,884	11,772	9,709	(32.7)
Franklin	26,088	23,946	24,141	22,387	(14.2)
Madison	16,444	15,065	15,682	12,463	(24.2)
Morehouse	33,709	32,463	34,803	31,938	(5.3)
Ouachita	101,663	115,387	139,241	142,191	39.9
Richland	23,824	21,774	22,187	20,629	(13.4)
Tensas	11,796	9,732	8,525	7,103	(39.8)
West Carroll	14,177	13,028	12,922	12,093	(14.7)
LOUISIANA PARISH TOTAL	283,026	287,980	315,302	300,216	6.1
STATE OF MISSISSIPPI	2,178,141	2,216,994	2,520,770	2,573,216	18.1
Adams	37,730	37,293	38,071	35,356	(6.3)
Bolivar	54,464	49,409	45,965	41,875	(23.1)
Claiborne	10,845	10,086	12,279	11,370	4.8
Coahoma	46,212	40,447	36,918	31,665	(31.5)
Holmes	27,096	23,120	22,970	21,604	(20.3)
Humphreys	19,093	14,601	13,931	12,134	(36.4)
Issaquena	3,576	2,737	2,513	1,909	(46.6)
Jefferson	10,142	9,295	9,181	8,653	(14.7)
Leflore	47,142	42,111	41,525	37,341	(20.8)
Panola	28,791	26,829	28,164	29,996	4.2
Quitman	21,019	15,888	12,636	10,490	(50.1)
Sharkey	10,738	8,937	7,964	7,066	(34.2)
Sunflower	45,750	37,047	34,844	32,867	(28.2)
Tallahatchie	24,081	19,338	17,157	15,210	(36.8)
Tunica	16,826	11,854	9,652	8,164	(51.5)
Warren	42,206	44,981	51,627	47,880	13.4
Washington	78,638	70,581	72,344	67,935	(13.6)
Wilkinson	13,235	11,099	10,021	9,678	(26.9)
Yazoo	31,653	27,314	27,349	25,506	(19.4)
MISSISSIPPI COUNTY TOTAL	569,237	502,967	495,111	456,699	(19.8)
TOTAL MRL STUDY AREA	1,027,276	966,247	996,501	930,291	(9.4)

TABLE 7-A-2
HISTORICAL HOUSING STATISTICS FOR THE VICKSBURG DISTRICT
MRL STUDY AREA

BY COUNTY/PARISH AND STATE	TOTAL HOUSEHOLDS (No.)			PERSONS PER HOUSEHOLD (No.)	
	1980	1990	GROWTH (%)	1980	1990
STATE OF ARKANSAS	816,065	891,179	9.2	2.7	2.6
Ashley	9,061	8,890	(1.9)	2.9	2.7
Chicot	5,993	5,557	(7.3)	3.0	2.8
Desha	6,640	5,957	(10.3)	3.0	2.8
Drew	6,200	6,342	2.3	2.8	2.6
Jefferson	30,588	30,001	(1.9)	2.9	2.7
Lincoln	3,918	3,796	(3.1)	3.0	2.8
ARKANSAS COUNTY TOTAL	62,400	60,543	(3.0)	2.9	2.7
STATE OF LOUISIANA	1411788	1,499,269	6.2	2.8	2.7
Caldwell	3,881	3,575	(7.9)	2.8	2.7
Catahoula	4,085	3,927	(3.9)	3.0	2.8
Concordia	7,578	7,341	(3.1)	2.9	2.8
East Carroll	3,615	3,129	(13.4)	3.1	3.0
Franklin	8,075	7,776	(3.7)	2.9	2.8
Madison	5,191	4,252	(18.1)	2.9	2.9
Morehouse	11,611	10,961	(5.6)	2.9	2.9
Ouachita	47,322	50,518	6.8	2.7	2.7
Richland	7,222	7,079	(2.0)	2.8	2.8
Tensas	2,938	2,515	(14.4)	2.9	2.8
West Carroll	4,496	4,394	(2.3)	2.8	2.7
LOUISIANA PARISH TOTAL	106,014	105,467	(0.5)	2.9	2.8
STATE OF MISSISSIPPI	827,169	911,374	10.2	2.9	2.8
Adams	12,806	13,262	3.6	2.9	2.6
Bolivar	13,571	13,292	(2.1)	3.1	3.0
Claiborne	3,574	3,342	(6.5)	3.0	2.8
Coahoma	11,692	10,530	(9.9)	3.0	2.9
Holmes	7,034	7,139	1.5	3.1	3.0
Humphreys	4,269	3,926	(8.0)	3.2	3.1
Issaquena	764	633	(17.1)	3.0	3.0
Jefferson	2,775	2,814	1.4	3.3	3.1
Leflore	13,003	12,749	(2.0)	3.0	2.8
Panola	8,880	10,130	14.1	3.0	2.9
Quitman	3,930	3,521	(10.4)	3.1	3.0
Sharkey	2,262	2,084	(7.9)	3.4	3.4
Sunflower	9,685	9,650	(0.4)	3.2	3.1
Tallahatchie	5,287	5,034	(4.8)	3.2	3.0
Tunica	2,814	2,526	(10.2)	3.3	3.2
Warren	17,355	17,407	0.3	2.9	2.7
Washington	22,948	22,593	(1.5)	3.1	3.0
Wilkinson	3,190	3,347	4.9	3.1	2.9
Yazoo	8,818	8,813	(0.1)	3.0	2.9
MISSISSIPPI COUNTY TOTAL	154,657	152,792	(1.2)	3.1	3.0
TOTAL MRL STUDY AREA	323,071	318,802	(1.3)	3.0	2.8

TABLE 7-A-3
CIVILIAN LABOR FORCE STATISTICS FOR THE VICKSBURG DISTRICT
MRL STUDY AREA

BY COUNTY/PARISH AND STATE	CIVILIAN LABOR FORCE 1970 (No.)	CIVILIAN LABOR FORCE 1980 (No.)	CIVILIAN LABOR FORCE 1990 (No.)	CIVILIAN LABOR FORCE OVERALL GROWTH (%)	TOTAL EMPLOYMENT 1970 (No.)	TOTAL EMPLOYMENT 1980 (No.)	TOTAL EMPLOYMENT 1990 (No.)	TOTAL EMPLOYMENT OVERALL GROWTH (%)	UNEMPLOYMENT RATE 1970 (%)	UNEMPLOYMENT RATE 1980 (%)	UNEMPLOYMENT RATE 1990 (%)
STATE OF ARKANSAS	688,630	940,880	1,066,368	54.9	649,697	875,733	994,289	53.0	5.7	6.9	6.8
Ashley	8,394	9,914	10,530	25.4	8,047	8,971	9,632	19.7	4.1	9.5	8.5
Chicot	5,361	5,679	5,817	8.5	4,890	5,296	5,004	2.3	8.8	6.7	14.0
Desha	6,216	7,120	6,533	5.1	5,824	6,602	5,758	(1.1)	6.3	7.3	11.9
Drew	5,576	7,680	8,047	44.3	5,300	6,983	7,414	39.9	4.9	9.1	7.9
Jefferson	29,372	36,289	36,899	25.6	27,553	33,526	33,236	20.6	6.2	7.6	9.9
Lincoln	3,633	4,106	4,395	21.0	3,419	3,872	4,045	18.3	5.9	5.7	8.0
ARKANSAS COUNTY TOTAL	58,552	70,788	72,221	23.3	55,033	65,250	65,089	18.3	6.0	7.8	9.9
STATE OF LOUISIANA	1,224,186	1,744,102	1,816,917	48.4	1,158,245	1,639,394	1,641,614	41.7	5.4	6.0	9.6
Caldwell	2,849	3,886	3,758	31.9	2,700	3,585	3,328	23.3	5.2	7.7	11.4
Catahoula	3,278	4,258	4,110	25.4	3,091	3,955	3,619	17.1	5.7	7.1	11.9
Concordia	7,276	8,542	7,910	8.7	6,807	7,954	6,931	1.8	6.4	6.7	12.4
East Carroll	3,412	3,782	3,256	(4.6)	3,067	3,395	2,471	(19.4)	10.1	10.2	24.1
Franklin	6,792	8,076	8,243	21.4	6,319	7,399	7,359	16.5	7.0	8.3	10.7
Madison	4,157	5,025	4,495	8.1	4,015	4,626	3,791	(5.6)	3.4	7.9	15.7
Morehouse	9,726	11,397	11,813	21.5	9,038	10,518	10,348	14.5	7.1	7.7	12.4
Ouachita	41,595	57,728	63,613	52.9	39,340	53,912	58,100	47.7	5.4	6.5	8.7
Richland	6,225	7,168	7,823	25.7	5,849	6,778	7,019	20.0	6.0	5.4	10.3
Tensas	2,525	2,714	2,525	0.0	2,388	2,534	2,212	(7.4)	5.4	6.6	12.4
West Carroll	3,604	3,882	4,582	27.1	3,228	3,598	4,036	25.0	10.4	7.3	11.9
LOUISIANA PARISH TOTAL	91,439	116,458	122,128	33.6	85,842	108,254	109,214	27.2	6.1	7.0	10.6
STATE OF MISSISSIPPI	756,487	1,009,374	1,123,485	48.5	718,948	937,206	1,028,773	43.1	5.0	7.1	8.4
Adams	12815	15522	14737	15.0	12101	14267	12895	6.6	5.6	8.1	12.2
Bolivar	15,388	15,917	16,665	8.3	13,942	14,299	14,284	2.5	9.4	10.2	14.3
Claiborne	2992	4389	3864	29.1	2765	3891	3078	11.3	7.6	11.3	20.3
Coahoma	11,935	12,696	11,457	(4.0)	11,018	11,104	9,878	(10.3)	7.7	12.5	13.8
Holmes	6,429	6,716	6,665	3.7	5,967	6,031	5,611	(6.0)	7.2	10.2	15.8
Humphreys	4,143	4,339	4,729	14.1	3,951	3,864	4,378	10.8	4.6	10.9	7.4
Issaquena	789	822	749	(5.1)	749	754	674	(10.0)	5.1	8.3	10.0
Jefferson	2308	3264	3103	34.4	2038	2725	2312	13.4	11.7	16.5	25.5
Leflore	14,357	15,295	14,759	2.8	13,471	13,896	13,082	(2.9)	6.2	9.1	11.4
Panola	8,924	10,524	12,340	38.3	8,277	9,562	11,167	34.9	7.3	9.1	9.5
Quitman	4,432	4,242	3,748	(15.4)	4,041	3,848	3,306	(18.2)	8.8	9.3	11.8
Sharkey	2,769	2,446	2,612	(5.7)	2,432	2,263	2,347	(3.5)	12.2	7.5	10.1
Sunflower	10,695	11,740	11,535	7.9	9,851	10,678	10,293	4.5	7.9	9.0	10.8
Tallahatchie	5,250	5,541	5,651	7.6	4,932	5,023	4,896	(0.7)	6.1	9.3	13.4
Tunica	3,005	2,834	2,842	(5.4)	2,695	2,413	2,360	(12.4)	10.3	14.9	17.0
Warren	16440	21927	21105	28.4	15724	20588	19373	23.2	4.4	6.1	7.8
Washington	23,778	27,521	27,538	15.8	21,983	25,290	24,131	9.8	7.5	8.1	12.4
Wilkinson	3,416	3,459	3,569	4.5	2,992	3,013	2,857	(4.5)	12.4	10.3	16.9
Yazoo	8,665	9,843	9,161	5.7	8,299	9,152	8,298	(0.0)	4.2	7.0	9.4
MISSISSIPPI COUNTY TOTAL	158,530	179,037	176,827	11.5	147,228	162,661	155,220	5.4	7.1	9.1	12.2
TOTAL MRL STUDY AREA	308,521	366,283	371,176	20.3	288,103	336,165	329,523	14.4	6.6	8.2	11.2

TABLE 7-A-4
EMPLOYMENT BY INDUSTRY STATISTICS FOR THE VICKSBURG DISTRICT
MRL STUDY AREA

BY COUNTY/PARISH AND STATE	1990 EMPLOYMENT (No.)	EMPLOYMENT BY INDUSTRY (%)					
		AGRICULTURE	MANUFACTURING	WHOLESALE AND RETAIL TRADE	FINANCE, INSURANCE, AND REAL ESTATE	HEALTH SERVICES	PUBLIC ADMINISTRATION
STATE OF ARKANSAS	994,289	4.9	22.5	21.3	4.7	8.4	4.0
Ashley	9,632	5.7	37.7	16.1	2.8	5.6	2.4
Chicot	5,004	17.5	17.3	17.0	4.2	9.0	6.0
Desha	5,758	15.9	22.1	18.4	3.0	6.4	5.7
Drew	7,414	5.0	31.3	17.7	2.0	6.8	4.0
Jefferson	33,236	3.3	18.5	19.9	4.5	8.5	7.8
Lincoln	4,045	11.3	23.2	15.6	2.6	7.1	11.0
ARKANSAS COUNTY TOTAL	65,089	6.6	23.3	18.5	3.7	7.6	6.4
STATE OF LOUISIANA	1,641,614	2.5	12.5	22.0	5.8	9.0	5.1
Caldwell	3,328	7.2	16.4	18.3	3.1	9.9	4.9
Catahoula	3,619	14.5	8.8	18.4	3.2	8.6	5.7
Concordia	6,931	7.9	10.9	23.8	5.1	8.1	3.7
East Carroll	2,471	20.9	9.8	16.3	5.9	7.7	6.2
Franklin	7,359	13.4	12.6	20.2	3.8	7.5	3.7
Madison	3,791	13.5	10.6	21.7	4.5	8.2	4.4
Morehouse	10,348	7.6	26.4	15.0	4.3	10.1	4.9
Ouachita	58,100	1.5	12.6	24.2	6.9	10.8	4.1
Richland	7,019	13.1	14.4	19.7	4.2	9.9	4.2
Tensas	2,212	28.6	4.6	14.9	4.8	5.6	4.7
West Carroll	4,036	16.9	16.7	15.3	4.1	6.3	4.7
LOUISIANA PARISH TOTAL	109,214	6.6	13.8	21.6	5.7	9.7	4.3
STATE OF MISSISSIPPI	1,028,773	3.6	23.4	19.9	4.7	8.0	4.8
Adams	12895	2.6	15.6	23.1	5.1	7.7	3.6
Bolivar	14,284	8.2	18.0	20.7	3.8	9.3	6.9
Claiborne	3078	4.6	20.6	12.8	3.5	3.1	6.3
Coahoma	9,878	10.4	12.8	21.3	4.3	9.9	6.4
Holmes	5,611	11.9	21.8	19.3	3.4	7.5	3.0
Humphreys	4,378	24.9	21.3	15.9	3.1	3.3	3.0
Issaquena	674	34.3	14.4	13.6	1.2	5.3	3.6
Jefferson	2312	3.4	24.6	19.0	2.1	3.7	7.0
Leflore	13,082	7.9	18.2	22.1	3.9	8.0	5.5
Panola	11,167	4.5	33.3	17.8	2.6	5.3	4.1
Quitman	3,306	12.6	26.0	16.4	3.1	6.8	5.6
Sharkey	2,347	26.2	11.0	16.4	3.0	5.5	4.4
Sunflower	10,293	12.3	23.3	20.5	2.9	4.5	7.6
Tallahatchie	4,896	14.1	29.7	13.7	3.2	4.6	7.3
Tunica	2,360	21.1	23.2	15.1	2.9	2.6	3.3
Warren	19373	2.4	14.5	18.6	3.8	8.4	6.0
Washington	24,131	6.8	19.8	22.7	3.8	7.4	4.8
Wilkinson	2,857	5.4	27.5	14.7	2.8	8.7	7.8
Yazoo	8,298	12.6	20.5	18.3	4.9	7.2	4.6
MISSISSIPPI COUNTY TOTAL	155,220	8.4	20.0	19.8	3.7	7.1	5.4
TOTAL MRL STUDY AREA	329,523	7.5	18.6	20.1	4.4	8.1	5.2

TABLE 7-A-5
EARNINGS BY INDUSTRY STATISTICS FOR THE VICKSBURG DISTRICT
MRL STUDY AREA

BY COUNTY/PARISH AND STATE	1990 EARNINGS ($MIL) a/	EARNINGS BY INDUSTRY (%)					
		AGRICULTURE	MANUFACTURING	RETAIL TRADE	FINANCE, INSURANCE, AND REAL ESTATE	HEALTH SERVICES	OTHER c/
STATE OF ARKANSAS							
Ashley	341.4	7.9	53.5	5.9	2.2	10.6	12.5
Chicot	115.9	18.7	14.7	8.1	6.0	13.9	19.3
Desha	181.9	23.2	20.6	9.1	3.3	11.3	18.7
Drew	179.4	13.2	33.2	8.6	2.6	12.8	9.1
Jefferson	1,137.5	2.2	20.3	8.3	3.3	20.5	25.0
Lincoln	89.7	26.4	16.3	5.3	1.6	8.9	14.8
ARKANSAS COUNTY TOTAL	2,046	8.0	26.5	7.9	3.1	16.5	17.9
STATE OF LOUISIANA							
Caldwell	72.3	11.4	7.6	9.9	4.1	28.6	19.9
Catahoula	71.0	23.2	1.4	8.6	4.7	17.4	21.8
Concordia	157.0	11.5	7.5	10.8	3.2	14.4	31.0
East Carroll	76.0	36.6	3.0	6.3	5.0	10.4	22.3
Franklin	142.0	23.3	10.1	10.5	4.0	15.6	15.0
Madison	76.0	14.6	3.7	13.4	2.7	23.4	17.6
Morehouse	282.8	14.1	30.2	8.1	2.1	18.5	14.8
Ouachita	1,816.5	1.0	18.3	10.3	7.4	28.2	19.8
Richland	170.7	12.8	18.4	8.0	2.7	18.9	20.8
Tensas	57.3	43.5	1.5	5.1	3.1	12.3	18.4
West Carroll	76.0	28.7	6.8	7.1	2.2	14.7	19.9
LOUISIANA PARISH TOTAL	2,998	8.1	16.4	9.7	5.7	24.0	19.8
STATE OF MISSISSIPPI							
Adams	434.8	0.4	24.4	11.7	3.5	23.9	23.6
Bolivar	360.1	14.0	22.3	9.6	3.4	15.8	14.8
Claiborne	179.4	6.3	9.3	3.1	1.1	b/	63.7
Coahoma	301.5	16.5	13.2	10.4	4.4	20.0	15.0
Holmes	122.1	16.7	17.9	10.6	3.2	18.1	11.3
Humphreys	152.0	48.4	15.6	5.9	2.0	10.2	9.4
Issaquena	12.5	60.0	0.8	2.7	b/	6.2	21.8
Jefferson	33.6	9.3	15.9	6.9	2.6	12.2	19.3
Leflore	442.3	7.8	16.1	10.9	3.1	22.5	21.1
Panola	274.1	3.5	35.9	10.0	2.6	14.4	16.6
Quitman	61.0	19.4	15.8	12.2	3.6	15.8	13.2
Sharkey	69.8	40.9	7.1	6.3	2.1	13.3	14.2
Sunflower	367.5	2.2	22.0	6.5	2.1	10.0	32.8
Tallahatchie	83.5	16.6	11.4	9.2	3.0	26.5	11.7
Tunica	59.8	34.4	14.3	8.2	2.5	12.0	14.4
Warren	626.7	1.4	22.0	10.3	2.7	19.0	13.0
Washington	725.1	7.3	20.0	10.7	3.3	20.4	22.5
Wilkinson	52.3	3.1	24.9	10.0	4.0	17.8	18.5
Yazoo	234.2	16.2	23.1	7.8	2.7	18.0	16.9
MISSISSIPPI COUNTY TOTAL	4,592	9.7	20.2	9.5	3.0	17.6	20.5
TOTAL MRL STUDY AREA	9,636	8.8	20.4	9.2	3.9	19.3	20.2

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

c/ Mining, Construction, Transportation, Public Utilities and other Services industries.

TABLE 7-A-6
PERSONAL AND PER CAPITA INCOME FOR THE VICKSBURG DISTRICT
MRL STUDY AREA
(1989)

BY COUNTY/PARISH AND STATE	PERSONAL INCOME (MILLION $) /a	PER CAPITA INCOME ($) /a
STATE OF ARKANSAS	30,811	13,107
Ashley	294	12,080
Chicot	146	9,284
Desha	176	10,500
Drew	197	11,355
Jefferson	1,049	12,275
Lincoln	135	9,841
ARKANSAS COUNTY TOTAL	1,997	11,520
STATE OF LOUISIANA	55,915	13,250
Caldwell	102	10,351
Catahoula	108	9,795
Concordia	218	10,454
East Carroll	73	7,549
Franklin	212	9,478
Madison	104	8,376
Morehouse	340	10,649
Ouachita	1,877	13,198
Richland	200	9,694
Tensas	70	9,838
West Carroll	115	9,483
LOUISIANA PARISH TOTAL	3,419	11,388
STATE OF MISSISSIPPI	30,931	12,020
Adams	417	11,797
Bolivar	359	8,583
Claiborne	84	7,391
Coahoma	282	8,904
Holmes	161	7,437
Humphreys	109	8,972
Issaquena	15	7,989
Jefferson	58	6,664
Leflore	419	11,217
Panola	282	9,390
Quitman	84	8,036
Sharkey	53	7,515
Sunflower	289	8,805
Tallahatchie	117	7,700
Tunica	66	8,035
Warren	648	13,532
Washington	737	10,844
Wilkinson	80	8,310
Yazoo	247	9,701
MISSISSIPPI COUNTY TOTAL	4,507	9,870
TOTAL MRL STUDY AREA	9,924	10,667

a/ Values are expressed in constant 1996 dollars.

TABLE 7-A-7
GENERAL AGRICULTURAL CHARACTERISTICS FOR THE VICKSBURG DISTRICT
MRL STUDY AREA

BY COUNTY/PARISH	Total Farms		Land in Farms		Average Size of Farms		Value of Farm Products Sold	
	1978	1992	1978	1992	1978	1992	1978	1992
AND STATE	(No.)	(No.)	(1000 Acres)	(1000 Acres)	(Acres)	(Acres)	($million) a/	($million) a/
STATE OF ARKANSAS								
Ashley	376	368	177	155	471	420	56.3	45.4
Chicot	468	409	305	321	652	784	86.5	75.8
Desha	507	406	303	295	598	725	98.1	79.1
Drew	483	380	147	112	304	294	33.6	21.5
Jefferson	562	417	330	280	587	671	101.7	79.5
Lincoln	440	356	220	213	505	598	69.0	68.9
ARKANSAS COUNTY TOTAL	2,836	2,336	1,482	1,375	523	588	445.2	370.2
STATE OF LOUISIANA								
Caldwell	281	264	68	58	242	221	17.5	12.7
Catahoula	573	433	289	245	445	567	63.6	45.7
Concordia	419	357	265	231	632	646	77.9	47.6
East Carroll	374	277	215	196	628	709	19.5	57.4
Franklin	1,077	929	262	262	290	282	83.6	72.2
Madison	409	325	253	259	653	798	90.4	61.2
Morehouse	450	434	278	266	631	612	102.6	82.1
Ouachita	460	429	94	87	237	204	32.2	23.5
Richland	736	622	264	245	368	394	71.1	68.2
Tensas	334	268	275	263	710	982	78.6	79.5
West Carroll	831	555	169	137	220	246	40.4	30.5
LOUISIANA PARISH TOTAL	5,944	4,893	2,432	2,249	409	460	677.3	580.5
STATE OF MISSISSIPPI								
Adams	113	159	120	93	575	587	19.1	11.6
Bolivar	593	478	476	403	803	843	177.3	110.8
Claiborne	178	219	146	100	511	459	29.3	8.4
Coahoma	326	237	274	260	840	1,097	116.7	82.1
Holmes	641	420	286	236	446	563	69.0	55.6
Humphreys	331	325	217	210	656	647	90.6	120.7
Issaquena	143	107	114	121	797	1,131	44.3	29.9
Jefferson	158	234	118	81	433	346	18.4	5.7
Leflore	343	281	351	277	1,023	986	130.6	99.0
Panola	844	643	305	238	361	370	62.9	33.8
Quitman	369	256	231	200	626	780	79.2	46.5
Sharkey	178	127	217	178	1,219	1,401	92.2	58.5
Sunflower	520	442	420	348	808	786	166.7	121.2
Tallahatchie	533	404	321	296	602	733	113.3	74.3
Tunica	204	162	239	245	1,172	1,514	93.5	65.1
Warren	167	222	130	107	484	482	23.2	17.7
Washington	487	394	386	356	793	903	144.6	129.6
Wilkinson	144	216	144	103	495	475	12.9	5.9
Yazoo	691	569	430	368	622	646	119.7	85.3
MISSISSIPPI COUNTY TOTAL	6,963	5,895	4,925	4,220	707	716	1,603.4	1,161.9
TOTAL MRL STUDY AREA	15,743	13,124	8,839	7,843	561	598	2,726.0	2,112.5

a/ Values are expressed in constant 1996 dollars.

TABLE 7-A-8A
BUSINESS AND INDUSTRIAL ACTIVITY FOR THE VICKSBURG DISTRICT
MRL STUDY AREA
(1977)

BY COUNTY/PARISH AND STATE	MANUFACTURING		WHOLESALE TRADE		RETAIL TRADE		SELECTED SERVICES	
	ESTABLISHMENTS (No.)	VALUE ADDED BY MANUFACTURING (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES RECEIPTS (MILLION $) a/
STATE OF ARKANSAS								
Ashley	68	b/	23	62.1	208	143.0	146	14.9
Chicot	17	11.9	31	58.0	195	84.0	107	7.8
Desha	22	139.6	38	212.9	200	127.4	106	13.2
Drew	34	134.5	26	44.3	163	106.2	96	7.1
Jefferson	93	475.3	140	695.7	772	665.3	590	78.9
Lincoln	9	b/	12	29.7	89	34.3	49	4.1
ARKANSAS COUNTY TOTAL	243	761.3	270	1,102.8	1,627.0	1,160.3	1,094	125.9
STATE OF LOUISIANA								
Caldwell	3	5.4	9	10.2	99	49.2	43	3.4
Catahoula	5	b/	18	132.8	119	61.4	62	4.4
Concordia	16	11.0	31	107.9	172	122.8	110	14.4
East Carroll	1,011	7.3	26	b/	90	57.5	37	9.5
Franklin	10	22.7	33	143.7	168	126.4	101	9.5
Madison	22	12.2	24	146.4	125	74.1	52	5.6
Morehouse	184	b/	31	133.0	277	201.5	127	17.1
Ouachita	14	572.7	264	1,550.6	1,189	1,205.1	980	200.2
Richland	4	20.2	33	123.3	228	140.8	107	8.8
Tensas	8	b/	10	70.9	65	30.2	37	2.2
West Carroll	831	7.8	23	52.4	123	64.1	74	4.9
LOUISIANA PARISH TOTAL	2,108	659.2	502	2,471.1	2,655.0	2,133.0	1,730	279.9
STATE OF MISSISSIPPI								
Adams	69	339.6	85	345.9	398	346.9	256	43.6
Bolivar	20	172.0	63	393.9	382	216.1	229	20.2
Claiborne	20	40.0	8	13.9	79	44.3	36	8.8
Coahoma	27	104.5	77	269.9	351	210.7	204	23.6
Holmes	25	29.0	24	62.9	196	87.9	71	103.0
Humphreys	10	16.3	26	117.2	130	51.6	45	124.5
Issaquena	0	0.0	2	b/	7	1.7	0	0.0
Jefferson	11	8.5	4	b/	62	24.1	24	0.7
Leflore	44	112.3	73	586.4	406	267.0	214	27.8
Panola	28	102.6	44	161.0	247	141.3	149	15.1
Quitman	7	b/	16	57.5	135	45.3	54	4.6
Sharkey	8	11.2	16	53.8	70	30.5	36	3.2
Sunflower	19	75.5	44	755.9	298	152.0	138	12.4
Tallahatchie	10	12.7	15	73.8	126	45.1	85	5.6
Tunica	6	b/	19	75.3	85	48.5	34	2.2
Warren	50	324.5	75	359.6	442	370.0	333	44.3
Washington	88	247.3	139	599.0	673	529.8	416	69.2
Wilkinson	29	40.2	15	38.7	86	40.0	42	2.4
Yazoo	28	225.3	36	172.7	240	143.0	131	12.7
MISSISSIPPI COUNTY TOTAL	499	1,861.4	781	4,137.4	4,413.0	2,795.9	2,497	524.0
TOTAL MRL STUDY AREA	2,850	3,281.9	1,553	7,711.4	8,695.0	6,089.2	5,321	929.8

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

TABLE 7-A-8B
BUSINESS AND INDUSTRIAL ACTIVITY FOR THE VICKSBURG DISTRICT
MRL STUDY AREA
(1992)

BY COUNTY/PARISH AND STATE	MANUFACTURING		WHOLESALE TRADE		RETAIL TRADE		SELECTED SERVICES	
	ESTABLISHMENTS (No.)	VALUE ADDED BY MANUFACTURING (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES RECEIPTS (MILLION $) a/
STATE OF ARKANSAS								
Ashley	44	b/	29	b/	241	125.4	72	19.6
Chicot	9	19.8	34	74.4	163	64.9	57	13.0
Desha	15	b/	35	110.1	225	110.2	63	16.6
Drew	35	107.1	23	58.5	184	110.5	58	16.6
Jefferson	87	542.9	124	380.2	914	648.6	455	179.3
Lincoln	9	7.8	9	19.6	88	23.5	18	6.3
ARKANSAS COUNTY TOTAL	199	677.7	254	642.8	1,815.0	1,083.2	723	251.4
STATE OF LOUISIANA								
Caldwell	24	8.7	6	b/	109	50.3	29	18.6
Catahoula	6	1.4	14	b/	109	43.6	31	6.1
Concordia	15	b/	30	b/	203	87.3	77	15.4
East Carroll	8	7.4	13	73.6	81	40.9	30	8.0
Franklin	11	19.8	29	125.4	194	124.3	58	17.3
Madison	7	9.6	14	44.3	122	72.4	49	19.7
Morehouse	21	b/	27	83.0	278	177.7	113	35.8
Ouachita	161	736.8	333	1,537.9	1,601	1,306.2	973	532.0
Richland	17	29.8	27	120.7	231	114.0	92	26.1
Tensas	6	6.4	15	181.6	75	22.1	25	2.9
West Carroll	10	13.1	13	25.3	115	118.3	31	8.5
LOUISIANA PARISH TOTAL	286	833.0	521	2,191.7	3,118.0	2,157.0	1,508	690.4
STATE OF MISSISSIPPI								
Adams	52	309.4	100	185.1	445	332.3	256	85.8
Bolivar	29	153.5	44	275.3	437	209.5	155	44.1
Claiborne	14	24.4	6	b/	74	29.3	28	5.6
Coahoma	32	118.3	67	223.3	377	208.3	142	44.0
Holmes	16	69.8	16	42.0	197	65.9	45	7.0
Humphreys	7	b/	20	74.9	104	52.2	38	8.7
Issaquena	3	0.7	3	b/	7	b/	1	b/
Jefferson	10	13.5	2	b/	62	13.8	10	1.8
Leflore	44	117.0	73	535.6	450	273.6	203	63.1
Panola	41	107.5	38	193.2	297	160.9	106	32.3
Quitman	7	21.1	12	22.3	107	34.9	25	4.2
Sharkey	7	b/	15	24.3	71	22.2	26	3.6
Sunflower	24	208.1	34	626.0	276	166.1	88	24.2
Tallahatchie	10	15.5	22	55.9	144	42.7	35	5.0
Tunica	5	b/	19	56.7	85	35.5	17	2.7
Warren	51	329.5	68	418.3	538	425.6	233	113.7
Washington	79	463.4	121	450.3	724	506.3	374	131.9
Wilkinson	20	27.5	20	39.4	104	35.3	34	8.9
Yazoo	21	93.7	42	112.6	254	113.0	91	17.9
MISSISSIPPI COUNTY TOTAL	472	2,073.2	722	3,335.2	4,753.0	2,727.5	1,907	604.4
TOTAL MRL STUDY AREA	957	3,583.8	1,497	6,169.7	9,686.0	5,967.6	4,138	1,546.2

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

TABLE 7-A-9
LOCAL GOVERNMENT FINANCIAL STATISTICS FOR THE VICKSBURG DISTRICT
MRL STUDY AREA
(1992)

BY COUNTY/PARISH AND STATE	TOTAL GENERAL REVENUE (MILLION $) /a	DIRECT GENERAL EXPENDITURE (MILLION $) /a
STATE OF ARKANSAS		
Ashley	38.7	34.2
Chicot	31.4	32.3
Desha	29.2	26.7
Drew	25.1	29.2
Jefferson	143.3	141.1
Lincoln	11.7	19.8
ARKANSAS COUNTY TOTAL	279.5	283.3
STATE OF LOUISIANA		
Caldwell	12.7	13.4
Catahoula	22.1	24.7
Concordia	32.0	32.4
East Carroll	15.5	15.6
Franklin	34.6	33.7
Madison	16.2	16.6
Morehouse	64.3	69.6
Ouachita	240.1	232.6
Richland	44.4	46.9
Tensas	10.9	11.3
West Carroll	14.8	14.4
LOUISIANA PARISH TOTAL	507.6	511.2
STATE OF MISSISSIPPI		
Adams	83.5	72.9
Bolivar	77.2	78.9
Claiborne	65.4	63.1
Coahoma	83.1	86.5
Holmes	44.1	42.5
Humphreys	18.3	19.1
Issaquena	2.7	2.8
Jefferson	14.8	13.8
Leflore	83.8	85.3
Panola	40.6	40.2
Quitman	19.8	18.3
Sharkey	12.9	12.4
Sunflower	59.6	58.0
Tallahatchie	24.9	22.9
Tunica	12.4	12.9
Warren	67.9	63.1
Washington	132.3	130.6
Wilkinson	18.2	19.7
Yazoo	34.6	33.2
MISSISSIPPI COUNTY TOTAL	896.2	876.4
TOTAL MRL STUDY AREA	1,683.3	1,670.9

a/ Values are expressed in constant 1996 dollars.

TABLE 7-A-10
BANK AND SAVINGS STATISTICS FOR THE VICKSBURG DISTRICT
MRL STUDY AREA
(1992)

BY COUNTY/PARISH AND STATE	BANKS NUMBER OF OFFICES	BANKS DEPOSITS (MILLION $) a/	SAVINGS INSTITUTIONS NUMBER OF OFFICES	SAVINGS INSTITUTIONS DEPOSITS (MILLION $) a/
STATE OF ARKANSAS				
Ashley	11	215.8	0	0.0
Chicot	6	141.6	0	0.0
Desha	8	189.4	0	0.0
Drew	8	171.7	1	19.9
Jefferson	26	945.2	0	0.0
Lincoln	5	65.0	0	0.0
ARKANSAS COUNTY TOTAL	64	1,728.6	1	19.9
STATE OF LOUISIANA				
Caldwell	3	69.4	1	31.0
Catahoula	6	109.4	0	0.0
Concordia	6	281.7	0	0.0
East Carroll	2	77.2	0	0.0
Franklin	8	182.2	0	0.0
Madison	4	103.4	0	0.0
Morehouse	8	279.1	0	0.0
Ouachita	43	1,640.1	2	66.4
Richland	7	231.2	0	0.0
Tensas	6	87.0	0	0.0
West Carroll	4	87.6	0	0.0
LOUISIANA PARISH TOTAL	97	3,148.1	3	97.4
STATE OF MISSISSIPPI				
Adams	9	302.8	3	69.4
Bolivar	19	301.5	2	36.8
Claiborne	2	88.9	0	0.0
Coahoma	14	326.2	1	14.2
Holmes	10	163.3	0	0.0
Humphreys	4	118.1	1	5.1
Issaquena	1	2.7	0	0.0
Jefferson	2	14.7	0	0.0
Leflore	15	401.1	1	15.9
Panola	12	239.1	1	23.4
Quitman	7	79.4	0	0.0
Sharkey	4	52.7	0	0.0
Sunflower	12	240.7	1	8.9
Tallahatchie	5	91.5	0	0.0
Tunica	2	67.7	0	0.0
Warren	19	519.7	1	6.0
Washington	26	518.1	4	93.7
Wilkinson	2	63.8	1	21.2
Yazoo	10	265.7	0	0.0
MISSISSIPPI COUNTY TOTAL	175	3,857.7	16	294.6
TOTAL MRL STUDY AREA	336	8,734.5	20	411.9

a/ Values are expressed in constant 1996 dollars.

ATTACHMENT 7-B
STATISTICS BY COUNTY
MEMPHIS DISTRICT - CEMVM

TABLE 7-B-1
HISTORICAL POPULATION STATISTICS FOR THE MEMPHIS DISTRICT
MRL STUDY AREA

BY COUNTY AND STATE	TOTAL POPULATION BY YEAR (No.)				
	1960	1970	1980	1990	OVERALL GROWTH (%)
STATE OF ARKANSAS	1,786,272	1,923,322	2,286,357	2,350,725	31.6
Arkansas	23,355	23,347	24,175	21,653	(7.3)
Craighead	47,303	52,068	63,239	68,959	45.8
Crittenden	47,564	48,106	49,499	49,939	5.0
Cross	19,551	19,783	20,434	19,225	(1.7)
Jackson	22,843	20,452	21,646	18,944	(17.1)
Lee	21,001	18,884	15,539	13,053	(37.8)
Mississippi	70,174	62,060	59,517	57,525	(18.0)
Monroe	17,327	15,657	14,052	11,333	(34.6)
Phillips	43,997	40,046	34,772	28,838	(34.5)
Poinsett	30,834	26,822	27,032	24,664	(20.0)
Prairie	10,515	10,249	10,140	9,518	(9.5)
St. Francis	33,303	30,799	30,858	28,497	(14.4)
ARKANSAS COUNTY TOTAL	387,767	368,273	370,903	352,148	(9.2)
STATE OF ILLINOIS	10,081,158	11,109,935	11,427,409	11,430,602	13.4
Pulaski	10,490	8,741	8,840	7,523	(28.3)
ILLINOIS COUNTY TOTAL	10,490	8,741	8,840	7,523	(28.3)
STATE OF KENTUCKY	3,038,156	3,218,706	3,660,324	3,685,296	21.3
Fulton	11,256	10,183	8,971	8,271	(26.5)
KENTUCKY COUNTY TOTAL	11,256	10,183	8,971	8,271	(26.5)
STATE OF MISSISSIPPI	2,178,141	2,216,912	2,520,770	2,573,216	18.1
DeSoto	12,891	35,885	53,930	67,910	426.8
MISSISSIPPI COUNTY TOTAL	12,891	35,885	53,930	67,910	426.8
STATE OF MISSOURI	4,319,713	4,676,501	4,916,766	5,117,073	18.5
Bollinger	9,167	8,820	10,301	10,619	15.8
Cape Girardeau	42,020	49,320	58,867	61,633	46.7
Dunklin	39,139	33,742	36,324	33,112	(15.4)
Mississippi	20,695	16,647	12,068	12,298	(40.6)
New Madrid	31,350	23,420	22,945	20,928	(33.2)
Pemiscott	38,095	26,373	24,987	21,921	(42.5)
Scott	32,748	33,250	39,647	39,376	20.2
Stoddard	29,490	25,771	29,009	28,895	(2.0)
MISSOURI COUNTY TOTAL	242,704	217,343	234,148	228,782	(5.7)
STATE OF TENNESSEE	3,567,089	3,923,726	4,594,023	4,877,185	36.7
Dyer	29,537	30,427	34,663	34,854	18.0
Gibson	44,699	47,871	49,467	46,315	3.6
Lake	9,572	7,896	7,455	7,129	(25.5)
Lauderdale	21,844	20,271	24,555	23,491	7.5
Obion	26,957	29,936	32,781	31,717	17.7
Shelby	627,019	722,014	777,113	826,330	31.8
Tipton	28,564	28,001	32,930	37,568	31.5
Weakley	24,227	28,827	32,896	31,972	32.0
TENNESSEE COUNTY TOTAL	812,419	915,243	991,860	1,039,376	27.9
TOTAL MRL STUDY AREA	1,477,527	1,555,668	1,668,652	1,704,010	15.3

TABLE 7-B-2
HISTORICAL HOUSING STATISTICS FOR THE MEMPHIS DISTRICT
MRL STUDY AREA

BY COUNTY AND STATE	TOTAL HOUSEHOLDS (No.) 1980	1990	GROWTH (%)	PERSONS PER HOUSEHOLD (No.) 1980	1990
STATE OF ARKANSAS	816,065	891,179	9.2	2.7	2.6
Arkansas	8,909	8,389	(5.8)	2.7	2.5
Craighead	22,334	26,285	17.7	2.8	2.5
Crittenden	15,701	17,120	9.0	2.9	2.9
Cross	6,631	6,754	1.9	3.0	2.8
Jackson	7,786	7,361	(5.5)	2.8	2.5
Lee	4,942	4,578	(7.4)	3.1	2.8
Mississippi	19,757	20,420	3.4	3.0	2.8
Monroe	4,920	4,361	(11.4)	2.8	2.6
Phillips	11,434	10,183	(10.9)	3.0	2.8
Poinsett	9,465	9,368	(1.0)	2.8	2.6
Prairie	3,658	3,661	0.1	2.8	2.6
St. Francis	9,930	9,958	0.3	3.1	2.8
ARKANSAS COUNTY TOTAL	125,467	128,438	2.4	2.9	2.7
STATE OF ILLINOIS	4045379	4,202,246	3.9	2.8	2.7
Pulaski	3,310	2,957	(10.7)	2.7	2.5
ILLINOIS COUNTY TOTAL	3,310	2,957	(10.7)	2.7	2.5
STATE OF KENTUCKY	1,263,355	1,379,782	9.2	2.8	2.6
Fulton	3,384	3,378	(0.2)	2.6	2.4
KENTUCKY COUNTY TOTAL	3,384	3,378	(0.2)	2.6	2.4
STATE OF MISSISSIPPI	827,169	911,374	10.2	3.0	2.8
Fulton	16,331	23,273	42.5	3.3	2.9
MISSISSIPPI COUNTY TOTAL	16,331	23,273	42.5	3.3	2.9
STATE OF MISSOURI	1793399	1,961,206	9.4	2.7	2.5
Bollinger	3,717	3,946	6.2	2.8	2.7
Cape Girardeau	20,968	23,390	11.6	2.6	2.5
Dunklin	13,588	13,128	(3.4)	2.7	2.5
Mississippi	5,511	5,411	(1.8)	2.8	2.6
New Madrid	7,965	7,715	(3.1)	2.9	2.7
Pemiscott	8,883	8,210	(7.6)	2.8	2.6
Scott	13,967	14,761	5.7	2.8	2.6
Stoddard	10,694	11,383	6.4	2.7	2.5
MISSOURI COUNTY TOTAL	85,293	87,944	3.1	2.8	2.6
STATE OF TENNESSEE	1,618,505	1,853,725	14.5	2.8	2.6
Dyer	12,696	13,617	7.3	2.7	2.5
Gibson	18,202	18,361	0.9	2.7	2.5
Lake	2,575	2,418	(6.1)	2.8	2.5
Lauderdale	8,281	8,423	1.7	2.9	2.7
Obion	12,079	12,412	2.8	2.7	2.5
Shelby	214,741	303,571	41.4	2.8	2.7
Tipton	10,778	13,033	20.9	3.0	2.9
Weakley	11,567	11,992	3.7	2.6	2.5
TENNESSEE COUNTY TOTAL	290,919	383,827	31.9	2.8	2.6
TOTAL MRL STUDY AREA	524,704	629,817	20.0	2.8	2.6

TABLE 7-B-3
CIVILIAN LABOR FORCE STATISTICS FOR THE MEMPHIS DISTRICT
MRL STUDY AREA

BY COUNTY AND STATE	CIVILIAN LABOR FORCE				TOTAL EMPLOYMENT				UNEMPLOYMENT RATE		
	1970 (No.)	1980 (No.)	1990 (No.)	OVERALL GROWTH (%)	1970 (No.)	1980 (No.)	1990 (No.)	OVERALL GROWTH (%)	1970 (%)	1980 (%)	1990 (%)
STATE OF ARKANSAS	688,630	940,880	1,066,368	54.9	649,697	875,733	994,289	53.0	5.7	6.9	6.8
Arkansas	8,674	10,316	9,841	13.5	8,287	9,820	9,228	11.4	4.5	4.8	6.2
Craighead	20,310	31,274	34,557	70.1	19,127	27,512	32,772	71.3	5.8	12.0	5.2
Crittenden	15,443	18,897	22,141	43.4	14,232	17,007	20,049	40.9	7.8	10.0	9.4
Cross	6,868	8,875	8,141	18.5	6,296	7,619	7,393	17.4	8.3	14.2	9.2
Jackson	7,131	9,397	7,930	11.2	6,477	7,742	7,153	10.4	9.2	17.6	9.8
Lee	4,869	4,963	4,529	(7.0)	4,298	4,234	3,853	(10.4)	11.7	14.7	14.9
Mississippi	19,431	21,374	23,403	20.4	17,558	19,570	20,907	19.1	9.6	8.4	10.7
Monroe	4,495	5,041	4,263	(5.2)	4,146	4,628	3,871	(6.6)	7.8	8.2	9.2
Phillips	11,794	11,657	10,303	(12.6)	10,495	10,165	9,188	(12.5)	11.0	12.8	10.8
Poinsett	9,155	10,668	10,809	18.1	8,494	10,387	9,626	13.3	7.2	2.6	10.9
Prairie	3,377	3,464	4,159	23.2	3,213	3,499	3,906	21.6	4.9	(1.0)	6.1
St. Francis	10,152	11,241	11,152	9.9	8,914	10,141	9,665	8.4	12.2	9.8	13.3
ARKANSAS COUNTY TOTAL	121,699	147,167	151,228	24.3	111,537	132,324	137,611	23.4	8.4	10.1	9.0
STATE OF ILLINOIS	4,591,634	5458758	5,803,007	26.4	4,419,915	5068428	5,417,967	22.6	3.7	7.2	6.6
Pulaski	2,666	3,035	2,800	5.0	2,563	2,697	2,434	(5.0)	3.9	11.1	13.1
ILLINOIS COUNTY TOTAL	2,666	3,035	2,800	5.0	2,563	2,697	2,434	(5.0)	3.9	11.1	13.1
STATE OF KENTUCKY	1,141,594	1,517,653	1,688,314	47.9	1,088,758	1,388,046	1,563,960	43.6	4.6	8.5	7.4
Fulton	3,672	3,448	3,204	(12.7)	3,435	3,036	2,890	(15.9)	6.5	11.9	9.8
KENTUCKY COUNTY TOTAL	3,672	3,448	3,204	(12.7)	3,435	3,036	2,890	(15.9)	6.5	11.9	9.8
STATE OF MISSISSIPPI	756,487	1,009,374	1,123,485	48.5	718,948	937,206	1,028,773	43.1	5.0	7.1	8.4
DeSoto	11,982	23,449	35,009	192.2	11,474	22,113	33,128	188.7	4.2	5.7	5.4
MISSISSIPPI COUNTY TOTAL	11,982	23,449	35,009	192.2	11,474	22,113	33,128	188.7	4.2	5.7	5.4
STATE OF MISSOURI	1,845,402	2,282,059	2,522,783	36.7	1,767,310	2,103,907	2,367,395	34.0	4.2	7.8	6.2
Bollinger	2,711	3,804	4,467	64.8	2,568	3,417	4,151	61.6	5.3	10.2	7.1
Cape Girardeau	20,403	28,411	31,691	55.3	19,572	26,705	29,939	53.0	4.1	6.0	5.5
Dunklin	11,099	13,770	13,292	19.8	10,297	12,269	11,883	15.4	7.2	10.9	10.6
Mississippi	5,160	5,831	5,935	15.0	4,781	5,228	5,429	13.6	7.3	10.3	8.5
New Madrid	6,930	8,451	8,513	22.8	6,404	7,722	7,596	18.6	7.6	8.6	10.8
Pemiscot	7,890	8,948	8,353	5.9	7,091	7,941	7,412	4.5	10.1	11.3	11.3
Scott	12,285	16,205	18,180	48.0	11,820	15,592	16,912	43.1	3.8	3.8	7.0
Stoddard	8,711	11,755	12,743	46.3	8,192	10,634	11,779	43.8	6.0	9.5	7.6
MISSOURI COUNTY TOTAL	75,189	97,175	103,174	37.2	70,725	89,508	95,101	34.5	5.9	7.9	7.8
STATE OF TENNESSEE	1,526,055	2,067,882	2,405,077	57.6	1,458,431	1,914,920	2,250,842	54.3	4.4	7.4	6.4
Dyer	8,693	15,128	16,789	93.1	8,430	14,036	15,652	85.7	3.0	7.2	6.8
Gibson	19,958	21,273	21,718	8.8	19,095	19,608	19,830	3.8	4.3	7.8	8.7
Lake	2,821	2,820	2,484	(11.9)	2,564	2,507	2,484	(3.1)	9.1	11.1	0.0
Lauderdale	6,550	9,551	10,189	55.6	6,125	8,540	9,071	48.1	6.5	10.6	11.0
Obion	12,446	14,376	15,187	22.0	11,987	13,389	14,176	18.3	3.7	6.9	6.7
Shelby	278,926	349,684	406,434	45.7	265,876	322,287	376,899	41.8	4.7	7.8	7.3
Tipton	8,797	13,157	17,091	94.3	8,228	12,167	15,776	91.7	6.5	7.5	7.7
Weakley	11,573	14,271	15,760	36.2	11,090	13,239	14,890	34.3	4.2	7.2	5.5
TENNESSEE COUNTY TOTAL	349,764	440,260	505,652	44.6	333,395	405,773	468,778	40.6	4.7	7.8	7.3
TOTAL MRL STUDY AREA	564,972	714,534	801,067	41.8	533,129	655,451	739,942	38.8	5.6	8.3	7.6

TABLE 7-B-4
EMPLOYMENT BY INDUSTRY STATISTICS FOR THE MEMPHIS DISTRICT
MRL STUDY AREA

BY COUNTY AND STATE	1990 EMPLOYMENT (No.)	EMPLOYMENT BY INDUSTRY (%)					
		AGRICULTURE	MANUFACTURING	WHOLESALE AND RETAIL TRADE	FINANCE, INSURANCE, AND REAL ESTATE	HEALTH SERVICES	PUBLIC ADMINISTRATION
STATE OF ARKANSAS	994,289	4.9	22.5	21.3	4.7	8.4	4.0
Arkansas	9,228	12.1	22.6	19.3	4.8	7.3	3.5
Craighead	32,772	4.3	21.8	22.1	5.2	8.6	2.6
Crittenden	20,049	5.3	14.4	25.0	5.9	7.3	3.9
Cross	7,393	12.5	26.9	18.8	4.3	6.8	2.2
Jackson	7,153	9.5	23.6	20.9	3.0	10.0	4.6
Lee	3,853	17.8	19.4	17.7	2.7	7.4	4.5
Mississippi	20,907	7.2	30.4	17.5	3.7	6.0	5.9
Monroe	3,871	14.6	18.8	23.4	3.8	4.0	2.9
Phillips	9,188	9.3	16.9	20.8	2.9	7.8	4.1
Poinsett	9,626	11.7	28.7	20.0	3.9	4.3	2.5
Prairie	3,906	20.1	20.7	20.5	3.5	4.3	2.7
St. Francis	9,665	8.2	18.1	22.5	3.5	6.7	4.1
ARKANSAS COUNTY TOTAL	137,611	8.4	22.2	21.1	4.4	7.1	3.7
STATE OF ILLINOIS	5,417,967	2.0	19.5	21.4	8.0	8.2	3.9
Pulaski	2,434	7.1	12.2	18.4	3.7	9.0	8.6
ILLINOIS COUNTY TOTAL	2,434	7.1	12.2	18.4	3.7	9.0	8.6
STATE OF KENTUCKY	1,563,960	3.8	19.5	21.3	5.2	8.3	4.3
Fulton	2,890	7.1	34.1	18.2	3.5	5.2	2.8
KENTUCKY COUNTY TOTAL	2,890	7.1	34.1	18.2	3.5	5.2	2.8
STATE OF MISSISSIPPI	1,028,773	3.6	23.4	19.9	4.7	8.0	4.8
DeSoto	33,128	2.0	19.2	25.0	4.4	5.1	3.3
MISSISSIPPI COUNTY TOTAL	33,128	2.0	19.2	25.0	4.4	5.1	3.3
STATE OF MISSOURI	2,367,395	3.4	18.6	21.7	6.3	9.2	4.3
Bollinger	4,151	10.0	31.8	17.1	2.9	6.1	2.8
Cape Girardeau	29,939	3.3	17.1	23.1	4.5	11.0	2.3
Dunklin	11,883	8.2	23.9	18.3	4.1	8.6	3.1
Mississippi	5,429	11.6	24.0	18.3	3.9	5.8	2.9
New Madrid	7,596	11.9	25.5	18.4	3.2	6.9	3.2
Pemiscot	7,412	8.7	27.0	18.9	3.9	8.9	8.2
Scott	16,912	4.1	21.4	25.2	4.4	8.1	2.3
Stoddard	11,779	8.9	27.3	19.5	2.5	7.3	3.2
MISSOURI COUNTY TOTAL	95,101	6.6	22.5	21.2	3.9	8.7	3.1
STATE OF TENNESSEE	2,250,842	2.3	23.3	21.3	5.3	8.5	4.2
Dyer	15,652	3.3	37.9	19.6	4.0	7.1	3.5
Gibson	19,830	4.3	40.8	17.0	3.4	7.7	3.1
Lake	2,484	7.0	31.6	14.2	1.7	4.0	13.3
Lauderdale	9,071	5.4	40.6	15.4	3.6	5.4	6.0
Obion	14,176	4.1	37.4	20.9	2.2	6.3	3.9
Shelby	376,899	1.1	12.7	23.5	6.5	10.3	5.4
Tipton	15,776	3.8	25.0	21.0	4.6	6.9	5.9
Weakley	14,890	4.3	32.7	16.4	3.2	7.3	3.5
TENNESSEE COUNTY TOTAL	468,778	1.7	17.2	22.5	5.9	9.6	5.2
TOTAL MRL STUDY AREA	739,942	3.6	18.9	22.1	5.3	8.8	4.6

TABLE 7-B-5
EARNINGS BY INDUSTRY STATISTICS FOR THE MEMPHIS DISTRICT
MRL STUDY AREA

BY COUNTY AND STATE	1990 EARNINGS ($MIL) a/	EARNINGS BY INDUSTRY (%)					
		AGRICULTURE	MANUFACTURING	RETAIL TRADE	FINANCE, INSURANCE, AND REAL ESTATE	HEALTH SERVICES	OTHER c/
STATE OF ARKANSAS							
Arkansas	289.9	13.8	24.3	9.1	3.3	b/	39.9
Craighead	917.5	1.7	23.1	10.8	3.6	25.6	21.4
Crittenden	410.4	8.2	16.8	13.0	3.5	23.4	21.1
Cross	179.8	20.8	23.7	9.0	3.0	11.6	17.1
Jackson	192.4	10.5	25.5	9.7	3.6	20.7	20.1
Lee	87.6	32.9	12.6	7.1	3.0	12.7	13.1
Mississippi	671.4	7.9	32.3	7.5	2.7	9.3	13.0
Monroe	105.0	31.0	12.9	11.5	3.3	12.5	16.5
Phillips	245.3	18.0	16.7	10.3	3.5	16.9	17.3
Poinsett	222.5	23.0	26.7	7.4	3.9	8.5	18.9
Prairie	78.2	34.1	15.0	9.8	2.2	10.4	16.1
St. Francis	241.6	10.5	19.4	11.0	3.0	17.0	18.6
ARKANSAS COUNTY TOTAL	3,642	11.2	23.2	11.0	3.3	16.1	19.9
STATE OF ILLINOIS							
Pulaski	66.9	14.5	11.4	4.5	2.4	12.4	30.7
ILLINOIS COUNTY TOTAL	67	14.5	11.4	4.5	2.4	12.4	62.8
STATE OF KENTUCKY							
Fulton	82.5	6.6	28.5	13.0	3.2	14.2	19.0
KENTUCKY COUNTY TOTAL	82	6.6	28.5	13.0	3.2	14.2	50.9
STATE OF MISSISSIPPI							
DeSoto	632.5	1.1	37.5	9.2	b/	17.4	25.9
MISSISSIPPI COUNTY TOTAL	633	1.1	37.5	9.2	0.0	17.4	21.2
STATE OF MISSOURI							
Bollinger	56.9	19.0	13.3	9.0	2.2	17.3	22.7
Cape Girardeau	953.2	1.4	18.5	11.1	3.6	31.1	22.3
Dunklin	264.3	8.7	19.6	11.8	4.0	21.2	20.0
Mississippi	120.2	15.9	14.4	10.0	2.6	12.4	30.0
New Madrid	275.2	16.4	40.6	7.0	1.6	7.4	17.5
Pemiscot	167.3	15.6	16.5	8.5	2.9	16.2	18.6
Scott	430.6	4.7	12.5	11.8	3.8	23.0	29.8
Stoddard	280.3	11.3	28.2	9.3	3.3	15.7	21.1
MISSOURI COUNTY TOTAL	2,548	7.4	20.6	10.4	3.3	22.3	22.8
STATE OF TENNESSEE							
Dyer	487.4	2.3	42.2	9.7	3.2	15.8	15.8
Gibson	546.6	2.3	44.6	9.9	2.7	13.9	16.1
Lake	46.6	15.0	26.1	11.5	6.7	10.6	12.7
Lauderdale	233.5	4.5	47.4	6.5	3.1	9.6	15.6
Obion	507.7	1.6	51.7	9.2	2.0	14.4	13.5
Shelby	15,695.3	0.1	13.1	9.8	6.3	25.3	28.6
Tipton	236.6	7.8	31.3	8.7	4.0	18.2	15.1
Weakley	321.7	3.0	28.7	9.4	3.1	17.1	17.0
TENNESSEE COUNTY TOTAL	18,275	0.5	16.9	9.7	5.9	23.9	26.8
TOTAL MRL STUDY AREA	25,247	2.9	18.7	9.8	5.1	22.4	25.5

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

c/ Mining, Construction, Transportation, Public Utilities and other Services industries.

TABLE 7-B-6
PERSONAL AND PER CAPITA INCOME FOR THE MEMPHIS DISTRICT
MRL STUDY AREA
(1989)

BY COUNTY AND STATE	PERSONAL INCOME (MILLION $) /a	PER CAPITA INCOME ($) /a
STATE OF ARKANSAS	30,811	13,107
Arkansas	301	13,915
Craighead	971	14,080
Crittenden	581	11,629
Cross	213	11,085
Jackson	210	11,081
Lee	107	8,201
Mississippi	623	10,828
Monroe	107	9,453
Phillips	240	8,338
Poinsett	270	10,954
Prairie	102	10,767
St. Francis	255	8,963
ARKANSAS COUNTY TOTAL	3,982	11,307
STATE OF ILLINOIS	216,483	18,939
Pulaski	79	10,564
ILLINOIS COUNTY TOTAL	79	10,564
STATE OF KENTUCKY	51,209	13,896
Fulton	101	12,235
KENTUCKY COUNTY TOTAL	101	12,235
STATE OF MISSISSIPPI	30,931	12,020
DeSoto	1,058	15,585
MISSISSIPPI COUNTY TOTAL	1,058	15,585
STATE OF MISSOURI	82,810	16,183
Bollinger	116	10,910
Cape Girardeau	911	14,774
Dunklin	372	11,248
Mississippi	137	11,145
New Madrid	236	11,255
Pemiscott	211	9,605
Scott	486	12,343
Stoddard	347	12,015
MISSOURI COUNTY TOTAL	2,815	12,305
STATE.OF TENNESSEE	74,467	15,269
Dyer	489	14,041
Gibson	593	12,804
Lake	74	10,322
Lauderdale	252	10,723
Obion	438	13,825
Shelby	13,724	16,608
Tipton	459	12,205
Weakley	393	12,281
TENNESSEE COUNTY TOTAL	16,421	15,799
TOTAL MRL STUDY AREA	24,456	14,353

a/ Values are expressed in constant 1996 dollars.

TABLE 7-B-7
GENERAL AGRICULTURAL CHARACTERISTICS FOR THE MEMPHIS DISTRICT
MRL STUDY AREA

BY COUNTY AND STATE	Total Farms		Land In Farms		Average Size of Farms		Value of Farm Products Sold	
	1978	1992	1978	1992	1978	1992	1978	1992
	(No.)	(No.)	(1000 Acres)	(1000 Acres)	(Acres)	(Acres)	($million) a/	($million) a/
STATE OF ARKANSAS								
Arkansas	748	490	468	411	178	840	176.9	127.4
Craighead	726	781	362	350	304	429	142.6	109.7
Crittenden	382	290	366	327	957	1,127	147.5	93.3
Cross	570	409	345	325	604	793	120.8	85.1
Jackson	550	450	359	368	654	818	106.9	77.4
Lee	635	313	324	299	511	954	105.6	77.4
Mississippi	856	546	187	485	350	888	53.3	169.7
Monroe	430	278	514	219	600	789	232.3	55.1
Phillips	841	352	75	357	201	1,015	21.3	110.5
Poinsett	718	619	415	405	578	654	173.8	130.0
Prairie	572	401	328	313	574	781	116.1	82.6
St. Francis	565	388	337	305	596	787	107.4	70.8
ARKANSAS COUNTY TOTAL	7,393	5,317	4,080	4,164	552	783	1,504.4	1,188.9
STATE OF ILLINOIS								
Pulaski	315	218	82	82	259	378	24.9	18.5
ILLINOIS COUNTY TOTAL	315	218	82	82	259	378	24.9	18.5
STATE OF KENTUCKY								
Fulton	277	164	105	97	128	590	27.5	24.4
KENTUCKY COUNTY TOTAL	277	164	105	97	128	590	27.5	24.4
STATE OF MISSISSIPPI								
DeSoto	610	488	217	140	356	288	62.6	28.7
MISSISSIPPI COUNTY TOTAL	610	488	217	140	356	288	62.6	28.7
STATE OF MISSOURI								
Bollinger	981	786	217	198	221	251	33.8	20.3
Cape Girardeau	1,468	1,203	287	253	195	210	75.9	51.3
Dunklin	1,273	537	308	289	323	538	128.0	97.7
Mississippi	421	293	271	265	644	905	114.6	89.5
New Madrid	714	442	205	369	230	835	59.5	113.3
Pemiscott	620	348	287	292	462	312	112.8	89.0
Scott	733	545	267	219	323	402	77.9	61.3
Stoddard	806	953	409	438	284	460	150.8	138.9
MISSOURI COUNTY TOTAL	7,016	5,107	2,251	2,322	321	455	753.3	661.3
STATE OF TENNESSEE								
Dyer	855	510	272	231	318	453	91.5	22.3
Gibson	1,517	898	306	272	201	303	93.3	73.9
Lake	134	85	87	91	647	1,075	49.8	28.4
Lauderdale	726	472	205	183	783	387	60.7	43.9
Obion	269	697	256	257	267	369	84.3	61.3
Shelby	761	609	194	145	255	238	60.8	33.4
Tipton	809	588	221	183	273	312	73.3	47.2
Weakley	1,293	857	224	204	173	238	71.5	55.4
TENNESSEE COUNTY TOTAL	6,364	4,716	1,765	1,566	277	332	585.1	365.9
TOTAL MRL STUDY AREA	21,975	16,010	8,500	8,371	387	523	2,957.9	2,287.7

a/ Values are expressed in constant 1996 dollars.

TABLE 7-B-8A

BUSINESS AND INDUSTRIAL ACTIVITY FOR THE MEMPHIS DISTRICT

MRL STUDY AREA

(1977)

BY COUNTY AND STATE	MANUFACTURING		WHOLESALE TRADE		RETAIL TRADE		SELECTED SERVICES	
	ESTABLISHMENTS (No.)	VALUE ADDED BY MANUFACTURING (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES RECEIPTS (MILLION $) a/
STATE OF ARKANSAS								
Arkansas	46	200.7	77	303.8	311	184.1	233	24.6
Craighead	105	368.5	129	358.4	702	554.1	507	66.6
Crittenden	53	b/	76	608.0	418	391.5	259	76.6
Cross	21	25.9	34	113.1	193	116.9	108	8.5
Jackson	26	79.3	43	98.4	244	141.5	140	15.4
Lee	7	b/	20	b/	122	58.7	54	4.1
Mississippi	64	469.5	89	351.5	569	396.9	331	40.7
Monroe	15	36.2	30	90.2	181	95.7	91	9.0
Phillips	3	0.5	4	6.6	359	214.8	165	21.5
Poinsett	26	85.1	44	118.5	344	143.9	178	9.3
Prairie	15	16.6	16	93.0	106	58.5	68	3.9
St. Francis	31	117.2	56	147.5	315	209.5	161	24.6
ARKANSAS COUNTY TOTAL	412	1,399.5	618	2,288.9	3,864.0	2,566.1	2,295	304.8
STATE OF ILLINOIS								
Pulaski	7	5.6	9	51.0	35	10.2	26	2.6
ILLINOIS COUNTY TOTAL	7	5.6	9	51.0	35	10.2	26	2.6
STATE OF KENTUCKY								
Fulton	9	20.5	24	140.8	153	100.7	72	6.9
KENTUCKY COUNTY TOTAL	9	20.5	24	140.8	153	100.7	72	6.9
STATE OF MISSISSIPPI								
DeSoto	62	161.8	39	285.7	309	210.5	234	21.0
MISSISSIPPI COUNTY TOTAL	62	161.8	39	285.7	309	210.5	234	21.0
STATE OF MISSOURI								
Bollinger	24	14.6	11	24.4	87	38.7	67	2.6
Cape Girardeau	91	345.2	162	852.5	602	541.8	538	87.0
Dunklin	42	180.0	81	208.2	111	52.5	80	3.4
Mississippi	14	19.5	31	243.0	175	111.0	99	6.9
New Madrid	16	b/	49	371.0	254	147.2	160	14.8
Pemiscott	19	60.0	59	277.2	280	129.5	156	13.6
Scott	6	b/	21	59.2	439	318.9	357	34.4
Stoddard	49	62.8	65	224.1	88	49.2	85	4.1
MISSOURI COUNTY TOTAL	261	682.1	479	2,259.5	2,036.0	1,388.7	1,542	166.9
STATE OF TENNESSEE								
Dyer	46	266.6	59	224.9	239	262.6	239	28.5
Gibson	60	371.8	79	199.8	534	293.1	359	30.7
Lake	10	29.7	14	25.9	92	36.6	66	3.9
Lauderdale	35	223.4	29	217.0	227	111.5	115	7.5
Obion	45	495.7	73	b/	34	247.4	238	23.9
Shelby	1,019	4,929.8	1,835	37,090.5	5,339	6,429.3	5,446	1,568.4
Tipton	22	73.9	29	141.3	281	153.0	166	11.5
Weakley	42	110.2	52	168.5	325	167.4	196	12.1
TENNESSEE COUNTY TOTAL	1,279	6,501.1	2,170	38,068.0	7,071.0	7,700.8	6,825	1,686.6
TOTAL MRL STUDY AREA	2,030	8,770.7	3,339	43,093.9	13,468.0	11,976.9	10,994	2,188.7

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

TABLE 7-B-8B
BUSINESS AND INDUSTRIAL ACTIVITY FOR THE MEMPHIS DISTRICT
MRL STUDY AREA
(1992)

BY COUNTY AND STATE	MANUFACTURING		WHOLESALE TRADE		RETAIL TRADE		SELECTED SERVICES	
	ESTABLISHMENTS (No.)	VALUE ADDED BY MANUFACTURING (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES RECEIPTS (MILLION $) a/
STATE OF ARKANSAS								
Arkansas	30	152.5	29	75.6	170	156.2	131	35.6
Craighead	114	429.3	149	349.3	551	745.9	485	285.9
Crittenden	47	139.0	84	434.9	247	398.5	225	128.9
Cross	18	b/	23	124.9	108	113.9	75	22.8
Jackson	25	102.0	40		135	130.0	112	59.8
Lee	3	b/	15	43.3	48	36.4	25	6.2
Mississippi	59	851.3	66	206.1	320	360.8	214	86.6
Monroe	15	7.2	30	59.2	80	69.5	51	13.1
Phillips	30	109.2	42	119.0	181	95.9	132	35.1
Poinsett	30	127.4	30	141.6	139	116.4	80	18.4
Prairie	11	350.8	13	30.8	67	45.6	29	7.5
St. Francis	31	b/	45	208.5	173	198.0	118	44.3
ARKANSAS COUNTY TOTAL	413	2,268.7	566	1,865.2	2,219.0	2,467.2	1,677	744.1
STATE OF ILLINOIS								
Pulaski	2	b/	8	146.7	40	16.9	16	3.8
ILLINOIS COUNTY TOTAL	2	b/	8	146.7	40	16.9	16	3.8
STATE OF KENTUCKY								
Fulton	13	58.0	20	80.5	73	65.6	38	19.2
KENTUCKY COUNTY TOTAL	13	58.0	20	80.5	73	65.6	38	19.2
STATE OF MISSISSIPPI								
DeSoto	138	681.3	75	1,381.5	314	442.5	283	143.3
MISSISSIPPI COUNTY TOTAL	138	681.3	75	1,381.5	314	442.5	283	143.3
STATE OF MISSOURI								
Bollinger	16	7.4	17	35.9	48	36.2	25	7.2
Cape Girardeau	101	845.9	196	775.6	539	741.8	523	267.2
Dunklin	30	130.5	81	186.9	222	218.0	161	63.6
Mississippi	12	25.6	25	139.8	86	89.8	51	16.9
New Madrid	15	b/	47	208.7	127	115.4	61	23.1
Pemiscott	20	8.9	36	178.2	123	91.8	59	22.0
Scott	62	224.4	100	892.6	267	305.9	247	95.9
Stoddard	52	91.8	59	148.2	192	226.4	145	49.2
MISSOURI COUNTY TOTAL	308	1,334.4	561	2,565.9	1,604.0	1,825.4	1,272	545.1
STATE OF TENNESSEE								
Dyer	40	393.9	65	334.6	266	327.7	202	83.3
Gibson	81	549.0	64	142.3	66	50.3	273	86.6
Lake	7	b/	9	14.1	33	20.3	21	6.4
Lauderdale	24	252.5	32	382.1	123	88.7	65	23.1
Obion	48	479.5	63	283.8	250	258.9	158	64.8
Shelby	1,028	5,950.5	2,091	3,077.0	4,738	8,127.9	5,909	5,013.6
Tipton	37	192.3	39	115.6	173	216.1	126	51.8
Weakley	56	247.7	58	161.1	185	159.7	122	86.2
TENNESSEE COUNTY TOTAL	1,321	8,065.4	2,421	4,510.7	5,834.0	9,249.5	6,876	5,415.7
TOTAL MRL STUDY AREA	2,195	12,407.9	3,651	10,550.5	10,084.0	14,067.0	10,162	6,871.1

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

TABLE 7-B-9
LOCAL GOVERNMENT FINANCIAL STATISTICS FOR THE MEMPHIS DISTRICT
MRL STUDY AREA
(1992)

BY COUNTY AND STATE	TOTAL GENERAL REVENUE (MILLION $) /a	DIRECT GENERAL EXPENDITURE (MILLION $) /a
STATE OF ARKANSAS		
Arkansas	25.2	28.2
Craighead	64.7	81.6
Crittenden	58.6	70.2
Cross	25.3	25.3
Jackson	17.5	16.8
Lee	14.9	13.3
Mississippi	64.5	62.7
Monroe	13.6	13.4
Phillips	37.9	12.8
Poinsett	22.3	23.3
Prairie	7.9	7.9
St. Francis	34.3	34.7
ARKANSAS COUNTY TOTAL	386.8	390.1
STATE OF ILLINOIS		
Pulaski	9.9	9.9
ILLINOIS COUNTY TOTAL	9.9	9.9
STATE OF KENTUCKY		
Fulton	10.7	13.7
KENTUCKY COUNTY TOTAL	10.7	13.7
STATE OF MISSISSIPPI		
DeSoto	57.3	52.3
MISSISSIPPI COUNTY TOTAL	57.3	52.3
STATE OF MISSOURI		
Bollinger	7.2	7.5
Cape Girardeau	57.3	60.5
Dunklin	40.0	41.3
Mississippi	18.9	18.5
New Madrid	21.5	23.0
Pemiscott	21.7	22.3
Scott	37.8	39.5
Stoddard	36.1	37.4
MISSOURI COUNTY TOTAL	240.5	249.9
STATE OF TENNESSEE		
Dyer	51.1	54.2
Gibson	62.8	58.7
Lake	6.9	6.3
Lauderdale	26.3	21.7
Obion	43.1	38.3
Shelby	1,410.9	1,466.5
Tipton	36.8	39.8
Weakley	25.8	23.6
TENNESSEE COUNTY TOTAL	1,663.7	1,709.0
TOTAL MRL STUDY AREA	2,368.9	2,424.9

a/ Values are expressed in constant 1996 dollars.

TABLE 7-B-10
BANK AND SAVINGS STATISTICS FOR THE MEMPHIS DISTRICT
MRL STUDY AREA
(1992)

BY COUNTY AND STATE	BANKS		SAVINGS INSTITUTIONS	
	NUMBER OF OFFICES	DEPOSITS (MILLION $) a/	NUMBER OF OFFICES	DEPOSITS (MILLION $) a/
STATE OF ARKANSAS				
Arkansas	11	450.0	0	0.0
Craighead	30	732.2	3	92.8
Crittenden	17	276.7	1	71.3
Cross	10	240.2	1	37.9
Jackson	10	178.4	1	35.5
Lee	3	69.2	0	0.0
Mississippi	22	408.3	3	54.2
Monroe	4	137.9	1	17.6
Phillips	12	294.8	0	0.0
Poinsett	10	259.7	3	20.7
Prairie	5	73.0	0	0.0
St. Francis	10	199.3	1	34.8
ARKANSAS COUNTY TOTAL	144	3,319.8	14	364.8
STATE OF ILLINOIS				
Pulaski	4	45.3	0	0.0
ILLINOIS COUNTY TOTAL	4	45.3	0	0.0
STATE OF KENTUCKY				
Fulton	6	162.3	2	33.0
KENTUCKY COUNTY TOTAL	6	162.3	2	33.0
STATE OF MISSISSIPPI				
DeSoto	27	418.5	2	36.1
MISSISSIPPI COUNTY TOTAL	27	418.5	2	36.1
STATE OF MISSOURI				
Bollinger	4	64.2	0	0.0
Cape Girardeau	21	1,155.2	2	82.9
Dunklin	15	402.0	3	43.9
Mississippi	4	143.5	2	15.6
New Madrid	10	145.9	1	17.3
Pemiscott	8	202.9	1	15.7
Scott	17	408.2	2	52.0
Stoddard	12	284.7	2	69.6
MISSOURI COUNTY TOTAL	91	2,806.4	13	297.0
STATE OF TENNESSEE				
Dyer	15	412.7	3	38.7
Gibson	27	635.0	0	0.0
Lake	5	41.1	0	0.0
Lauderdale	13	271.9	0	0.0
Obion	19	476.4	0	0.0
Shelby	192	8,758.4	19	1,694.0
Tipton	14	345.0	1	41.2
Weakley	17	384.6	0	0.0
TENNESSEE COUNTY TOTAL	302	11,325.0	23	1,773.9
TOTAL MRL STUDY AREA	574	18,077.4	54	2,504.8

a/ Values are expressed in constant 1996 dollars.

ATTACHMENT 7-C
STATISTICS BY PARISH
NEW ORLEANS DISTRICT - CEMVN

TABLE 7-C-1
HISTORICAL POPULATION STATISTICS FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA

BY PARISH AND STATE	TOTAL POPULATION BY YEAR (No.)				
	1960	1970	1980	1990	OVERALL GROWTH (%)
STATE OF LOUISIANA	3,257,022	3,644,637	4,206,116	4,219,973	29.6
Ascension	27,927	37,086	50,068	58,214	108.5
Assumption	17,991	19,654	22,084	22,753	26.5
Avoyelles	37,606	37,751	41,393	39,159	4.1
East Baton Rouge	230,058	285,167	366,191	380,105	65.2
Iberville	29,939	30,746	32,159	31,049	3.7
Jefferson	208,769	338,229	454,592	448,306	114.7
LaFourche	55,381	68,941	82,483	85,860	55.0
Orleans	627,525	593,471	557,927	496,938	(20.8)
Placquemines	22,545	25,225	26,049	25,575	13.4
Pointe Coupe	22,488	22,002	24,045	22,540	0.2
St. Bernard	32,186	51,185	64,097	66,631	107.0
St. Charles	21,219	29,550	37,259	42,437	100.0
St. James	18,369	19,733	21,495	20,879	13.7
St. John the Baptist	18,439	23,813	31,924	39,996	116.9
St. Landry	81,493	80,364	84,128	80,331	(1.4)
St. Martin	29,063	32,453	40,214	43,978	51.3
West Baton Rouge	14,796	16,864	19,086	19,419	31.2
West Feliciana	12,395	10,761	12,186	12,915	4.2
LOUISIANA PARISH TOTAL	1,508,189	1,722,995	1,967,380	1,937,085	28.4

TABLE 7-C-2
HISTORICAL HOUSING STATISTICS FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA

BY PARISH AND STATE	TOTAL HOUSEHOLDS (No.)			PERSONS PER HOUSEHOLD (No.)	
	1980	1990	GROWTH (%)	1980	1990
STATE OF LOUISIANA	1,411,788	1,499,269	6.2	2.8	2.7
Ascension	15,494	19,337	24.8	3.2	3.0
Assumption	6,479	7,397	14.2	2.4	3.0
Avoyelles	13,544	13,480	(0.5)	3.0	2.8
East Baton Rouge	124,346	138,620	11.5	2.8	2.7
Iberville	9,634	9,875	2.5	3.2	3.0
Jefferson	155,685	166,398	6.9	2.9	2.7
LaFourche	25,391	28,835	13.6	3.2	2.9
Orleans	206,435	188,235	(8.8)	2.6	2.6
Placquemines	7,750	8,213	6.0	3.3	3.0
Pointe Coupe	7,703	7,736	0.4	3.1	2.9
St. Bernard	20,591	23,156	12.5	3.1	2.9
St. Charles	11,487	14,333	24.8	3.2	2.9
St. James	6,046	6,432	6.4	3.5	3.2
St. John the Baptist	9,305	12,710	36.6	3.4	3.1
St. Landry	26,823	27,477	2.4	3.1	2.9
St. Martin	12,173	14,634	20.2	3.3	3.0
West Baton Rouge	5,800	6,606	13.9	3.3	2.9
West Feliciana	2,313	2,741	18.5	3.2	2.9
LOUISIANA PARISH TOTAL	666,999	696,215	4.4	3.1	2.9

TABLE 7-C-3
CIVILIAN LABOR FORCE STATISTICS FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA

BY PARISH AND STATE	CIVILIAN LABOR FORCE				TOTAL EMPLOYMENT				UNEMPLOYMENT RATE		
	1970 (No.)	1980 (No.)	1990 (No.)	OVERALL GROWTH (%)	1970 (No.)	1980 (No.)	1990 (No.)	OVERALL GROWTH (%)	1970 (%)	1980 (%)	1990 (%)
STATE OF LOUISIANA	1,224,186	1,744,102	1,816,917	48.4	1,158,245	1,639,394	1,641,614	41.7	5.4	6.0	9.6
Ascension	11,420	19,867	25,638	124.5	10,805	18,682	23,556	118.0	5.4	6.0	8.1
Assumption	5,291	7,802	8,867	67.6	4,929	7,352	7,905	60.4	6.8	5.8	10.8
Avoyelles	10,806	13,744	13,975	29.3	9,859	12,551	11,863	20.3	8.8	8.7	15.1
East Baton Rouge	107,422	171,057	187,884	74.9	102,577	161,997	172,715	68.4	4.5	5.3	8.1
Iberville	8,863	12,234	12,122	36.8	8,018	11,148	10,807	34.8	9.5	8.9	10.8
Jefferson	127,048	214,909	222,939	75.5	122,345	205,987	207,479	69.6	3.7	4.2	6.9
LaFourche	21,900	33,376	35,020	59.9	20,964	32,154	32,168	53.4	4.3	3.7	8.1
Orleans	221,532	235,250	213,034	(3.8)	208,787	218,693	186,036	(10.9)	5.8	7.0	12.7
Placquemines	8,229	9,712	10,296	25.1	7,905	9,200	9,219	16.6	3.9	5.3	10.5
Pointe Coupe	6,084	8,429	8,660	42.3	5,510	7,699	7,650	38.8	9.4	8.7	11.7
St. Bernard	18,423	28,010	30,559	65.9	17,521	16,599	27,859	59.0	4.9	5.0	8.8
St. Charles	9,297	16,133	19,212	106.6	8,910	15,146	17,802	99.8	4.2	6.1	7.3
St. James	4,976	8,775	8,393	68.7	4,976	8,124	7,598	52.7	6.6	7.4	9.5
St. John the Baptist	6,682	13,217	17,419	160.7	6,321	12,244	15,928	152.0	5.4	7.4	8.6
St. Landry	22,120	29,806	28,926	30.8	20,569	27,941	25,000	21.5	7.0	6.3	13.6
St. Martin	8,971	15,831	18,221	103.1	8,301	14,989	16,380	97.3	7.5	5.3	10.1
West Baton Rouge	4,982	7,737	8,884	78.3	4,583	7,187	8,039	75.4	8.0	7.1	9.5
West Feliciana	1,929	3,081	3,376	75.0	1,745	2,887	3,055	75.1	9.5	6.3	9.5
LOUISIANA PARISH TOTAL	605,975	848,970	873,425	44.1	574,625	790,580	791,059	37.7	5.2	6.9	9.4

TABLE 7-C-4
EMPLOYMENT BY INDUSTRY STATISTICS FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA

BY PARISH AND STATE	1990 EMPLOYMENT (No.)	EMPLOYMENT BY INDUSTRY (%)					
		AGRICULTURE	MANUFACTURING	WHOLESALE AND RETAIL TRADE	FINANCE, INSURANCE, AND REAL ESTATE	HEALTH SERVICES	PUBLIC ADMINISTRATION
STATE OF LOUISIANA	1,641,614	2.5	12.5	22.0	5.8	9.0	5.1
Ascension	23,556	1.7	22.7	21.2	5.1	6.0	4.1
Assumption	7,905	6.0	21.7	17.7	4.4	5.4	2.1
Avoyelles	11,863	6.1	8.9	20.6	4.8	10.3	10.8
East Baton Rouge	172,715	1.1	12.1	21.4	7.1	7.5	6.5
Iberville	10,807	3.3	22.2	17.0	4.8	7.6	7.1
Jefferson	207,479	1.0	9.8	25.5	7.8	9.3	4.6
LaFourche	32,168	3.4	14.2	19.9	4.0	7.6	2.8
Orleans	186,036	0.8	6.8	20.8	6.1	11.3	6.1
Placquemines	9,219	7.9	10.6	21.0	3.3	3.9	6.6
Pointe Coupe	7,650	7.1	11.8	17.4	5.6	6.1	6.7
St. Bernard	27,859	1.0	14.0	25.1	7.4	7.1	5.6
St. Charles	17,802	0.7	20.0	21.3	5.3	6.3	4.0
St. James	7,598	4.0	29.7	15.2	3.3	6.9	3.9
St. John the Baptist	15,928	1.4	21.1	21.8	6.4	6.6	3.8
St. Landry	25,000	3.9	10.2	21.5	4.6	10.9	4.2
St. Martin	16,380	4.2	21.0	22.8	3.9	5.2	2.6
West Baton Rouge	8,039	2.0	20.2	19.5	5.2	6.9	7.4
West Feliciana	3,055	2.2	11.2	14.6	5.3	8.8	17.6
LOUISIANA PARISH TOTAL	791,059	1.6	11.6	22.2	6.5	8.8	5.4

TABLE 7-C-5
EARNINGS BY INDUSTRY STATISTICS FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA

BY PARISH AND STATE	1990 EARNINGS ($MIL) a/	EARNINGS BY INDUSTRY (%)					
		AGRICULTURE	MANUFACTURING	RETAIL TRADE	FINANCE, INSURANCE, AND REAL ESTATE	HEALTH SERVICES	OTHER c/
STATE OF LOUISIANA							
Ascension	815.9	0.8	37.0	7.0	2.2	13.7	31.7
Assumption	159.5	6.8	42.8	5.7	2.9	11.7	15.8
Avoyelles	206.8	10.0	6.8	12.4	4.8	22.9	19.5
East Baton Rouge	6,635.7	0.2	13.0	8.8	6.1	28.0	24.5
Iberville	588.1	1.4	57.5	3.7	1.4	10.3	13.1
Jefferson	5,942.9	0.0	10.3	13.8	6.5	30.0	29.7
LaFourche	726.4	1.8	11.1	8.8	4.4	23.2	32.4
Orleans	10,242.5	0.0	6.8	7.8	7.3	34.3	26.3
Placquemines	669.0	0.6	11.4	3.0	0.9	9.6	54.4
Pointe Coupe	169.4	13.2	3.1	9.4	3.6	b/	54.1
St. Bernard	452.3	0.7	28.0	11.4	3.2	24.4	18.5
St. Charles	804.9	0.4	39.3	4.3	0.6	9.1	38.3
St. James	376.3	1.9	51.2	3.0	1.9	5.7	26.6
St. John the Baptist	411.1	1.1	34.9	6.3	1.7	15.5	29.7
St. Landry	574.4	5.0	13.6	10.8	4.9	26.7	19.0
St. Martin	294.0	3.2	33.6	10.7	3.0	16.4	17.9
West Baton Rouge	247.9	8.8	26.5	5.5	b/	8.1	39.3
West Feliciana	238.0	3.2	26.8	1.3	0.7	b/	41.2
LOUISIANA PARISH TOTAL	29,555	0.6	14.0	9.0	5.7	27.5	27.6

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

c/ Mining, Construction, Transportation, Public Utilities and other Services industries.

TABLE 7-C-6
PERSONAL AND PER CAPITA INCOME FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA
(1989)

BY PARISH AND STATE	PERSONAL INCOME (MILLION $) /a	PER CAPITA INCOME ($) /a
STATE OF LOUISIANA	55,915	13,250
Ascension	760	13,060
Assumption	229	10,063
Avoyelles	335	8,564
East Baton Rouge	8,468	22,278
Iberville	498	16,024
Jefferson	9,552	21,306
LaFourche	1,379	16,058
Orleans	10,264	20,655
Plaquemines	845	33,045
Pointe Coupee	644	28,583
St. Bernard	2,427	36,423
St. Charles	1,869	44,049
St. James	711	34,074
St. John the Baptist	1,605	40,129
St. Landry	1,853	23,067
St. Martin	1,197	27,224
West Baton Rouge	684	35,240
West Feliciana	158	12,201
LOUISIANA PARISH TOTAL	43,479	22,445

a/ Values are expressed in constant 1996 dollars.

TABLE 7-C-7

GENERAL AGRICULTURAL CHARACTERISTICS FOR THE NEW ORLEANS DISTRICT

MRL STUDY AREA

BY PARISH AND STATE	Total Farms		Land in Farms		Average Size of Farms		Value of Farm Products Sold	
	1978	1992	1978	1992	1978	1992	1978	1992
	(No.)	(No.)	(1000 Acres)	(1000 Acres)	(Acres)	(Acres)	($million) a/	($million) a/
STATE OF LOUISIANA								
Ascension	255	263	59	58	231	221	14.8	17.3
Assumption	144	118	77	72	537	608	27.5	30.3
Avoyelles	1,418	1,080	308	272	217	252	98.3	52.4
East Baton Rouge	538	582	107	84	199	145	18.4	10.6
Iberville	234	174	105	81	447	467	27.7	26.8
Jefferson	68	102	8	16	117	154	1.8	1.5
LaFourche	399	366	208	123	250	336	38.8	30.9
Orleans	9	7	b/	11	11	2	0.2	0.0
Placquemines	126	117	47	43	375	634	2.5	3.4
Pointe Coupe	566	439	204	196	360	446	52.2	43.7
St. Bernard	29	22	7	6	232	267	300.8	185.1
St. Charles	56	72	38	38	671	523	2.0	0.0
St. James	116	75	51	48	437	645	21.8	22.1
St. John the Baptist	42	39	21	19	500	483	7.9	6.8
St. Landry	1,569	1,159	325	269	207	232	94.7	49.9
St. Martin	430	299	88	73	205	245	25.7	26.1
West Baton Rouge	119	95	37	42	311	447	10.4	11.6
West Feliciana	194	106	102	89	554	519	7.9	7.7
LOUISIANA PARISH TOTAL	6,312	5,115	1,792	1,540	284	301	753.6	526.2

a/ Values are expressed in constant 1996 dollars.

b/ Value is less than 100.

TABLE 7-C-8A
BUSINESS AND INDUSTRIAL ACTIVITY FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA
(1977)

BY PARISH AND STATE	MANUFACTURING		WHOLESALE TRADE		RETAIL TRADE		SELECTED SERVICES	
	ESTABLISHMENTS (No.)	VALUE ADDED BY MANUFACTURING (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES RECEIPTS (MILLION $) a/
STATE OF LOUISIANA								
Ascension	55	1,491.8	52	b/	389	375.2	260	34.8
Assumption	15	31.2	16	246.0	152	69.7	74	6.3
Avoyelles	37	51.2	45	131.3	354	208.5	211	13.4
East Baton Rouge	291	3,402.0	655	3,953.5	2,441	3,245.6	2,738	847.8
Iberville	36	1,546.2	25	b/	271	172.5	144	27.5
Jefferson	391	1,432.7	1,020	13,430.5	3,007	4,225.1	3,400	1,043.4
LaFourche	76	179.1	83	235.3	685	545.4	459	73.8
Orleans	540	1,492.1	1,072	7,649.2	4,075	4,345.0	4,647	1,936.6
Placquemines	43	586.8	65	366.9	207	136.7	170	84.8
Pointe Coupe	17	20.5	25	78.4	195	116.2	79	6.6
St. Bernard	34	819.7	42	600.0	400	359.8	359	38.7
St. Charles	24	1,926.7	24	188.8	203	144.2	159	29.2
St. James	25	621.0	17	40.7	153	103.8	79	9.3
St. John the Baptist	17	272.8	20	195.6	194	130.6	135	19.2
St. Landry	63	95.3	144	364.4	746	512.5	533	55.5
St. Martin	32	60.4	35	336.2	304	149.8	151	7.8
West Baton Rouge	14	87.7	20	b/	106	59.0	86	11.9
West Feliciana	10	b/	3	b/	57	1,264.3	29	2.4
LOUISIANA PARISH TOTAL	1,720	14,117.0	3,363	27,816.9	13,939.0	16,163.8	13,713	4,249.2

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

TABLE 7-C-8B
BUSINESS AND INDUSTRIAL ACTIVITY FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA
(1992)

BY PARISH AND STATE	MANUFACTURING		WHOLESALE TRADE		RETAIL TRADE		SELECTED SERVICES	
	ESTABLISHMENTS (No.)	VALUE ADDED BY MANUFACTURING (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES (MILLION $) a/	ESTABLISHMENTS (No.)	SALES RECEIPTS (MILLION $) a/
STATE OF LOUISIANA								
Ascension	57	1,910.3	78	183.5	572	386.8	229	104.2
Assumption	10	33.2	14	b/	191	70.4	43	12.4
Avoyelles	38	22.8	44	b/	431	175.8	126	41.1
East Baton Rouge	323	2,284.3	829	3,555.2	3,591	3,654.7	3,099	1,790.5
Iberville	31	1,279.8	28	106.7	289	162.9	113	48.2
Jefferson	382	1,105.2	1,314	b/	4,518	4,869.4	3,623	2,453.9
LaFourche	63	159.9	101	235.6	889	500.4	378	122.4
Orleans	371	1,583.7	793	5,839.3	4,264	3,735.0	3,920	3,237.7
Placquemines	43	b/	94	1,329.3	254	184.4	150	102.7
Pointe Coupe	10	15.4	20	45.8	207	93.2	58	12.7
St. Bernard	50	388.3	63	473.1	587	429.8	316	133.1
St. Charles	28	2,370.7	53	1,852.5	280	139.3	146	66.3
St. James	28	415.4	19	b/	173	77.9	53	18.6
St. John the Baptist	22	494.4	43	b/	281	205.3	149	104.6
St. Landry	44	157.1	133	297.8	845	422.8	397	144.6
St. Martin	33	170.8	42	182.7	362	159.1	99	21.0
West Baton Rouge	34	b/	33	731.3	158	85.6	59	21.0
West Feliciana	3	b/	3	13.1	84	32.0	32	16.2
LOUISIANA PARISH TOTAL	1,570	12,391.4	3,704	14,845.9	17,976.0	15,384.6	12,990	8,451.0

a/ Values are expressed in constant 1996 dollars.

b/ Data is not shown to avoid disclosure of individual firms.

TABLE 7-C-9
LOCAL GOVERNMENT FINANCIAL STATISTICS FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA
(1992)

BY PARISH AND STATE	TOTAL GENERAL REVENUE (MILLION $) /a	DIRECT GENERAL EXPENDITURE (MILLION $) /a
STATE OF LOUISIANA		
Ascension	111.9	110.2
Assumption	26.3	25.7
Avoyelles	59.5	66.1
East Baton Rouge	684.0	615.0
Iberville	57.0	55.5
Jefferson	972.3	1,011.0
LaFourche	155.5	149.0
Orleans	1,189.8	1,101.2
Plaquemines	88.3	93.0
Pointe Coupee	59.2	55.7
St. Bernard	95.5	101.4
St. Charles	104.5	107.6
St. James	78.9	63.8
St. John the Baptist	49.7	58.4
St. Landry	144.0	146.2
St. Martin	58.2	60.8
West Baton Rouge	47.4	40.1
West Feliciana	50.1	53.4
LOUISIANA PARISH TOTAL	4,032.1	3,914.1

a/ Values are expressed in constant 1996 dollars.

TABLE 7-C-10
BANK AND SAVINGS STATISTICS FOR THE NEW ORLEANS DISTRICT
MRL STUDY AREA
(1992)

BY PARISH AND STATE	BANKS		SAVINGS INSTITUTIONS	
	NUMBER OF OFFICES	DEPOSITS (MILLION $) a/	NUMBER OF OFFICES	DEPOSITS (MILLION $) a/
STATE OF LOUISIANA				
Ascension	13	400.9	0	0.0
Assumption	7	140.4	0	0.0
Avoyelles	17	310.0	0	0.0
East Baton Rouge	121	4,616.9	10	275.7
Iberville	13	319.1	1	27.0
Jefferson	84	3,128.4	32	1,763.1
LaFourche	38	903.0	4	201.8
Orleans	83	7,284.1	29	1,596.7
Placquemines	7	179.9	1	15.7
Pointe Coupe	11	215.9	0	0.0
St. Bernard	22	568.1	2	156.8
St. Charles	16	260.5	1	15.7
St. James	9	257.2	1	13.0
St. John the Baptist	8	255.8	1	15.9
St. Landry	35	653.7	5	163.6
St. Martin	14	267.4	2	33.5
West Baton Rouge	5	111.9	0	0.0
West Feliciana	2	62.7	0	0.0
LOUISIANA PARISH TOTAL	505	19,935.7	89	4,278.5

a/ Values are expressed in constant 1996 dollars.

APPENDIX 8
AQUATIC RESOURCES

EVALUATION OF AQUATIC IMPACTS OF MISSISSIPPI RIVER MAINLINE LEVEES PROJECT

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Prepared for
U.S. Army Engineer Districts, New Orleans, Vicksburg, and Memphis

PREFACE

This report is an appendix to the supplemental environmental impact statement (SEIS) describing aquatic impacts of the Mississippi River Main Line Levees project. The SEIS was prepared by the U.S. Army Engineer Districts, New Orleans (CEMVN), Vicksburg (CELMK), and Memphis (CEMVM). An aquatic habitat evaluation team was formed to determine the approach for habitat quantification and included members from seven state fish and wildlife agencies (Louisiana, Mississippi, Arkansas, Tennessee, Missouri, Illinois, Kentucky), the United States Fish and Wildlife Service (USFWS), and Corps of Engineers (Appendix I). Biologists from each Corps District who helped coordinate the study and prepare the aquatic appendix were Marvin Cannon (CEMVK), Stuart McLean (CEMVK), Larry Hartzog (CEMVN), Greg Williams (CEMVM), and Edward Lambert (CEMVM). Each Corps District furnished project specifications including borrow area acres created for each alternative and provided morphometric configurations of borrow areas. Kent Parrish (CEMVK) and Steve Reed (CEMVK) assisted in choosing sampling locations. Independent technical reviews of this appendix were provided by the following individuals: Bruce Baird (CEMVN), Gary Young (CEMVK), and Richard Hite (CEMVM).

The following individuals at U.S. Army Engineer Waterways Experiment Station (CEWES) assisted with field work: Reid Adams, Steven George, Sherry Lynn Harrel, Bradley Lewis, James Morrow, Jr., Catherine Murphy, Tracy Robinson, and Larry Sanders. Assistance in the field and with identification of juvenile and adult fishes was provided by Neil H. Douglas, Northeast Louisiana University.

During the conduct of this study, Dr. John Harrison was Director, Environmental Laboratory, Dr. Conrad J. Kirby was Chief, Ecological Research Division, and Dr. Ed Theriot was Chief, Aquatic Ecology Branch at CEWES.

Commander CEWES during publication of this report was COL Bruce K. Howard, CE, and the Director was Dr. Robert W. Whalin.

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ABSTRACT

Borrow areas, permanent water bodies on the floodplain, will be created during proposed levee construction along the lower Mississippi River. The Habitat Evaluation Procedure was used to evaluate the No Action Alternative and two structural alternatives: Plan 3 - traditional construction techniques, and Plan 4 - avoid/minimize approach that utilizes environmental design features to optimize aquatic habitat of borrow areas. Multivariate regression models were used to predict fish abundance from habitat variables specific to each alternative. Models were developed from an existing data base for five evaluation taxa: buffalo, silversides, channel catfish, largemouth bass, and warmouth. Fish abundance was correlated with 5 different physical variables: mean depth and shoreline length of borrow areas, annual days flooded, turbidity, and conductivity. For each taxon and each alternative, a Habitat Suitability Index (HSI) was calculated as a ratio: predicted fish abundance / maximum observed fish abundance.

Habitat Units, the product of HSI and acres of borrow areas, increased for Plans 3 and 4, indicating that the MRL project will improve aquatic habitat. Creation of permanent borrow areas in the batture will result in HU gains ranging from 57 to 34,456 depending on District. The avoid/minimize plan provided higher habitat value per acre than that of the traditional plan because relatively deep borrow areas with irregular shorelines, islands, and possible plantings of riparian vegetation will be constructed during levee enlargement. Average Annual Habitat Units (AAHU) gained during the 100-yr life of the project, cumulative among all evaluation species and Corps Districts, were 30,549 and 27,381 for traditional and avoid/minimize plans, respectively. Lower AAHU's for the avoid/ minimize plan were attributable to lower acreages of borrow areas created during construction.

Fish communities were compared for seven borrow areas sampled in 1981 and 1996-97. Differences between years were substantial, and predicted and observed values of fish abundance were disparate confirming that standing crop and density are temporally variable. Long-term changes in physical habitat of borrow areas and variability in annual flooding regime likely contributes to inconsistent predictions of juvenile and adult fish abundance in borrow areas. Species diversity measures, however, confirmed fishery value of larger, deeper borrow areas.

INTRODUCTION

The U.S. Army Engineer Districts, New Orleans (CEMVN), Vicksburg (CEMVK), and Memphis (CEMVM) are controlling seepage (i.e., berms, slurry trenches, relief wells) and raising portions of levees along the lower Mississippi River. The purpose of the project is to accommodate the project design flood flows as part of a comprehensive plan of flood control, channel stabilization, and river regulation known as the Mississippi River and Tributaries Project (U.S. Army Engineer District, Vicksburg, 1976).

Borrow areas, varying in morphometry and size, will be created by excavation of fill material for levee construction. There are currently 38,000 - 42,000 acres of borrow areas in the lower Mississippi River (Baker et al. 1991). For the purposes of this study, riverside (i.e., batture) borrow areas are defined as permanent water bodies that are inundated during floods, are greater than one surface acre, and have average depths of at least 1 foot during late summer and fall. Landside borrow areas have the same attributes but are isolated from the Mississippi River. Some borrow areas are managed by levee districts to ensure long-term integrity of the waterbody or adjacent lands. Management actions include water level control, allowing hardwoods to grow along the shoreline, and ensuring that the toe of the levee is not compromised by seepage from the borrow area.

As rivers rise, fishes move laterally onto the floodplain and spawn (Guillory 1979; Kwak 1988). Borrow areas, like oxbow lakes, that are connected to main river channels, either continuously or during floods, function as important fish nursery areas (Beecher et al. 1977; Fischer and Kelso 1988; Leitman et al. 1991; Baker et al. 1991) and an ecotone between swift and slackwater habitats. Depending on morphometry, larval fish can concentrate in borrow areas, and once re-connected, these borrow areas contribute fish back to the river (Sabo and Kelso 1991; Sabo et al. 1991) and increase prey for main stream animals (Eckblad et al. 1984; Amoros 1991). Thus, borrow areas not only augment the rapid loss of Mississippi River backwaters from sedimentation and eutrophication (Fremling et al. 1989), but provide important habitat to fishes and other aquatic fauna.

We evaluated potential effects of the project on the habitat value of borrow areas. The project area encompasses the lower Mississippi River from Cape Girardeau to the mouth (970 river miles), and included the batture area, which is the land between the riverside toes of the

west and east bank main-line levees, and a three thousand foot strip of land parallel to and landside of the main-line levee toe. Our objective was to quantify changes in fish habitat for riverside borrow areas associated with each project alternative using the Habitat Evaluation Procedure (HEP) (USFWS 1980), including borrow area designs that increase habitat value for fishes. In addition, quantitative comparisons of the fish community were made between riverside and landside borrow areas to rank the relative habitat value among borrow areas that were seasonally contiguous and isolated from the Mississippi River. Results were presented separately for each Corps District and combined to provide a system-wide analysis of project effects.

METHODS

Ecological surveys of main-line levee borrow areas along the lower Mississippi River were conducted in the early 1980's. Results were published in a series of four reports, one of which summarized fishery investigations (Cobb et al.1984), another providing environmental design considerations for borrow areas (Aggus and Plosky 1986). These documents were used as a basis for developing habitat models to evaluate project alternatives. Of three alternatives for the SEIS (see Alternatives Section, Project Report), only two are applicable to the aquatic studies:

(1) No Action Alternative: Stop all new construction to include seepage control, berms, and levee enlargement. This alternative is equivocal to existing conditions without project.

(2) Structural Alternatives:

Plan 3: Traditional plan - Features of this plan include construction of relief wells, slurry trenche cutoffs, levee enlargement, berms, and some wave water protection in the Memphis District; the construction of earthen berms, relief wells, and levee enlargement in the Vicksburg District; and levee enlargement and paving in the New Orleans District. For logistics and cost effectiveness, borrow material used to construct these features would be taken as close to the construction sites as possible.

Plan 4: Avoid and minimize plan - This plan includes the same structural features as Plan 3 with additional environmental design features to avoid and minimize impacts to riverside wetlands. Features include (1) relocating borrow areas to less environmentally sensitive areas,

(2) using existing berm material to raise and enlarge the levee, (3) replace the excavated berm with material dredged from the river, and in lieu of constructing berms to control seepage, use relief wells or slurry trenches, and (4) incorporate environmental design features (e.g., maximize depth and size of borrow area) to ensure high habitat value.

Habitat Evaluation Procedure

We compared habitat tradeoffs among the alternatives using Habitat Suitability Index (HSI) values derived from multivariate regression models as specified in the Habitat Evaluation Procedure (USFWS 1980). Multiple-regression models were developed from previously collected field data (Cobb et al. 1984) and used to predict fishery responses to anticipated changes in physical habitat. Multiple regression equations are empirical, do not entail *a priori* decisions regarding relationships between habitat parameters and fishes, and thus reduce institutional bias. Instead, habitat value is assessed directly from baseline relationships between fish abundance (density or biomass) and physical habitat (area morphometry, flood frequency, and water quality). Multiple regression eliminates irrelevant variables from the final predictive model and quantifies correlation between habitat variables and fish abundance.

Meetings were held with interagency teams of biologists (Attachment A) and evaluation taxa were selected:

Buffalo (bigmouth, smallmouth, and black buffalos, collectively)
Channel catfish
Silversides (brook and inland silversides, collectively)
Largemouth bass
Warmouth

All evaluation species are numerically abundant in borrow areas (Baker et al. 1991; Cobb et al. 1984) and represent important commercial, recreational, and forage fishes of the lower Mississippi River system. These species provide broad representation of habitat preferences (surface and demersal, littoral and pelagic), reproductive biology (early and late spawners, egg broadcasters, and nesting species), and trophic levels (planktivores, benthivores, and piscivores).

Multiple regression models were developed from existing database of 25 borrow areas surveyed in 1981 (Cobb et al. 1984). The dependent variable for small taxa was density (number/acre); the dependent variable for large taxa was biomass (pounds/acre). Dependent variables were log transformed ($\log_{10}$ +1) to adjust for heterogeneity of variances. Independent variables included days flooded and 15 empirical and derived parameters describing morphometry and water quality of borrow areas (described in Cobb et al. 1984). Scatter plots of dependent and independent variables were examined visually to evaluate linear relationships. Outlying data points were identified as disparities in fish abundance that obscured existing linear relationships or that created artificial trends in fish-habitat relationships not supported by majority of observations.

Correlations between fish abundance (dependent variable) and physical parameters (independent variables) were identified using Pearson correlation analysis. Variables with correlation coefficients greater than 0.30 or were statistically significant ($p \leq 0.05$) were retained for regressions. However, intercorrelated independent variables (e.g., shoreline length, shoreline development index) were eliminated to avoid collinearity that results in spurious relationships with the dependent variable. Predictive equations were generated from a technique that accounted for maximum variance (RMAX) while limiting final equation to no more than three variables (SAS, 1993). Variables retained in the final equation were those contributing more than a 5% improvement in R^2 value or a significant reduction in the error term (p). Generic form of this equation is:

$$\text{Fish abundance} = b + m_1(\text{Habitat parameter 1}) + m_2(\text{Habitat parameter 2})\ldots$$

in which b (y-intercept) and m (slope) are constants calculated from linear relationships between dependent and independent variables.

Values for independent variables used in regression models differed among alternatives (Table 1). Values for no action alternative (i.e., existing borrow areas) were the means of hydrologic, morphometric, and water quality data presented by Cobb et al. (1984) for borrow areas that lie within the boundaries of each District (i.e., MVN-4, MVK-14, and MVM-7 borrow areas). In the Vicksburg and Memphis Districts, values for independent variables were the same for no action alternative and traditional plan. In the New Orleans District, values were the same for both structural plans (traditional and avoid and minimize) because engineering design of borrow areas was similar.

Table 1. Comparison of mean summer values for physicochemical (independent) variables of borrow areas used in regression models for each project alternative.

Variable	No Action Alternative			Plan 3: Traditional Construction			Plan 4: Avoid and Minimize		
	MVN	MVK	MVM	MVN	MVK	MVM	MVN	MVK	MVM
Surface Area, acres	18.1	15.9	26.2	2.75	15.9	26.2	2.75	100	10
Mean Depth, ft	5.4	2.9	2.3	8.3	2.9	2.3	8.3	8.0	9.0
Maximum Depth, ft	10.8	5.5	6.1	15.0	5.5	6.1	15.0	10.0	10.0
Percent Area > 5 feet	64.4	21.8	17.7	54.0	21.8	17.7	54.0	90.0	90.0
Percent Area > 10 ft	10.2	2.2	1.2	7.6	2.2	1.2	7.6	0.0	0.0
Shoreline Length, ft	8,386	5,285	7,749	1,600	5,285	7,749	1,600	18,000	2,640
Shoreline Development Index	2.6	1.8	2.3	1.3	1.8	2.3	1.3	2.4	1.1
Volume, yds^3	149,447	84,141	135,748	35,783	84,141	135,748	35,783	340,092	142,617
Volume Development Index	1.6	1.5	1.3	1.6	1.5	1.3	1.6	2.4	2.7
Mean Basin Slope	0.1	0.01	0.001	0.13	0.01	0.001	0.13	0.04	-0.02
Number of Days Flooded	90	88	72	100	88	72	100	88	72
Dissolved Oxygen, mg/l	5.0	7	7	5.0	7	7	5.0	7.0	7.0
pH	7.8	8.1	8.3	7.8	8.1	8.3	7.8	8.1	8.3
Conductivity, μmhos/cm	314	329	269	314	329	269	314	329	269
Water Temperature, °C	32	31	32	32	31	32	32	31	32
Turbidity, NTU	23	28	27	23	28	27	23	28	27

The avoid and minimize plan represented optimum habitat based on recommended environmental design of borrow areas along the lower Mississippi River (Aggus and Plosky 1986). No changes in water quality values were assumed between alternatives.

Model output was standardized to a 0-1 scale using the following relationship:

$$HSI = \frac{\text{Predicted Value of Fish Abundance}}{\text{Maximum Value of Fish Abundance}}$$

Values for HSI range from 0.00 (no habitat value) to 1.00 (optimal habitat). Maximum value of fish abundance was maximum standing crop or number per acre measured in 1981. The calculated HSI may occasionally exceed 1.0 when using values of habitat variables outside the range that was used to construct models; these values were always standardized to 1.0.

HSI values were multiplied by area (acres of borrow areas) to express project alternatives as Habitat Units (HU) according to the following equation:

$$HU = HSI \times Area$$

Existing acres of borrow areas within the boundaries of each District were estimated from satellite imagery using a GIS system (CERDS) of the lower Mississippi River (Cobb and Williamson 1985). Thus, the no action alternative represented acres of borrow areas that have been created up to 1997. Acres of borrow areas that would be created for traditional and avoid/minimize plans were determined from engineering specifications on borrow material required to raise portions of the levee and construct berms at individual work item locations (see Appendix 4, Plates).

Characterizing Borrow Area Fish Communities

Concurrent sampling of fish and habitat occurred in eight riverside borrow areas, seven of which were previously sampled by Cobb et al. (1984), and in 4 landside borrow areas (Table 2). Borrow areas were sampled in mid- to late summer when isolated from the Mississippi River.

Table 2. Location of riverside and landside borrow areas sampled in 1996 and 1997. Riverside numbers correspond to classification used by Cobb et al. (1984).

Location Relative to Levee	Site Designation	River Mile	Bank (L-left, R-right)	State	Date Sampled
		New Orleans District			
Riverside	#25	180	L	LA	18 Aug 97
	Bayou Goula	194	R	LA	12 Aug 97
		Vicksburg District			
Riverside	#2	407	R	LA	24 Jul 96
	#6	433	R	LA	22 Jul 96
	#9	595	L	MS	30 Jul 96
Landside	#1	497	R	LA	15 Sep 97
	#2	494	R	LA	15 Sep 97
	#3	493	R	LA	15 Sep 97
	#4	492	R	LA	15 Sep 97
		Memphis District			
Riverside	#13	656	R	AR	21 Jul 97
	#15	659	L	MS	28 Jul 97
	#17	773	R	AR	5 Aug 97

The same hydrologic, morphometric, and water quality variables measured by Cobb et al. (1984) were obtained by survey crews (Table 1). In each riverside borrow area, two 1-acre plots were rotenoned (1% concentration) and fish identified to species, measured, and weighed (Davies and Shelton 1983). These data were used to evaluate accuracy and precision of HSI model predictions and assess long-term (15 years) changes in physical and biotic conditions of borrow areas.

Fish were also collected with seines and gill nets in five riverside borrow areas (Bayou Goula, borrow area numbers 25, 13, 15, and 17) and in the four landside borrow areas (Table 2). Shoreline fishes were collected using a 20' X 8' seine with 3/16" mesh; standard effort was 10 hauls stratified among all apparent macrohabitats. Pelagic (offshore) fishes were collected with gillnets (90' X 6' with 0.75, 1.5, 2.0, 2.5, 3.0, 3.5" stretch mesh); standard effort was overnight sets of 5 gillnets set perpendicular to shore. Shoreline fishes were preserved in 10% formalin.

Larger fishes were identified in the field and released. In the laboratory, fishes were washed, identified, and counted. Specimens were catalogued and deposited as holdings in the Northeast Louisiana University Museum of Zoology, or retained for collections at the Environmental Laboratory, Waterways Experiment Station. These data were used to compare fish assemblages between riverside borrow areas seasonally contiguous with the river and landside borrow areas permanently isolated from the river.

Taxonomic composition of fish community - Data pooled for all sampling gears were used to compile species lists, describe the fish community inhabiting borrow areas, and determine similarity of fish assemblages among areas. We quantified similarity using Jaccard's Index, an expression of taxonomic similarity based on presence-absence of each species (Magurran, 1988). It is calculated as:

$$J=\frac{C}{A+B-C}$$

in which

C = number of taxa co-occurring in two species lists, a and b (e.g., two borrow areas),

A = total number of taxa occurring in species list a (e.g., one borrow area),

B = total number of taxa occurring in species list b (e.g., another borrow area).

J ranges from 0.00 (no taxa in common) to 1.00 (all taxa shared) and quantifies the percentage of taxa shared between two collections (e.g., areas). This index satisfies all logical conditions required of a binary (presence-absence) index of association (or similarity), although it exhibits slight curvilinear response to changes in species number (Hubalek, 1982). It is generally unbiased at small sample sizes, and interpreted unambiguously (Ludwig and Reynolds, 1988).

Species-abundance analyses - Data were analyzed separately for each gear type so that values presented for each species represented a catch-per-unit-effort or CPUE. We assumed that rotenone data represented littoral and pelagic communities combined, and that seining data and gillnet data represent littoral and pelagic communities separately.

Diversity of fish assemblages in individual borrow areas was described using indices of species richness, heterogeneity, and evenness. CPUE and diversity were used to identify longitudinal differences in fish assemblages (i.e., rotenone data for Memphis, Vicksburg, and

New Orleans Districts) and differences attributable to riverine connection (i.e., seining and gill netting data for riverside and landside borrow areas). For gillnet data, comparisons of diversity among individual borrow areas were not possible due to low numbers of fish collected in three of four landside sites ($N \leq 50$). Very small samples bias some analyses (i.e., estimates of heterogeneity and evenness) and limit interpretations of others (i.e., species richness). Consequently, we presented gillnet data obtained from individual borrow areas but for species-abundance analyses we used aggregated data (i.e., species richness) or mean CPUE (i.e., community resemblance) to compare fish communities of riverside and landside borrow areas.

Species richness was expressed using rarefaction (Hurlbert, 1971). This technique compensates for different numbers of fishes among samples (i.e., borrow areas). For any sample, it quantifies number of species expected, or $E(S_n)$, from a random subsample of specified size. This allows species richness for an equally-sized subsample to be compared among all borrow areas. Larger subsamples increase discriminant ability of this measure but maximum size of subsample is limited by: 1) minimum number of individuals (fish) in any one sample (borrow area); 2) maximum number observed of a single species (CPUE) in all samples (Ludwig and Reynolds, 1988). For rotenone data, consisting of very large numbers of fishes, we used a standardized subsample of n = 2000 fish for comparisons among borrow areas. For seining data, consisting of smaller numbers of fishes, we used a standardized subsample of n = 85 fish. Results were presented as rarefaction curves (Ludwig and Reynolds, 1988). Curve shape provides information on community structure, minimum sampling effort required to detect differences in species richness among samples, and whether additional species would be expected with additional sampling effort.

Shannon's heterogeneity function (H') incorporates both components of species diversity: species richness (number of species collected) and evenness (equitability of relative abundance among species). Several variants of the Shannon formula exist, based largely on choice of log-functions. We used the common variant based on natural log (ln):

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Values of H' range from near-zero (domination by a single species) to lnS (all species equally abundant), although in most natural communities, H' ranges from 1.00 - 4.00 (Magurran, 1988).

Evenness was calculated separately as:

$$E = \frac{\sum_{i=1}^{S} p_i^2 - 1}{e^{H'} - 1}$$

Evenness ranges from near-zero (domination by a single species) to 1.00 (when all species are equally abundant). This measure, unlike many evenness indices, is relatively unbiased by variation in species richness (Ludwig and Reynolds, 1988).

Classification, or cluster, analysis was used to simultaneously compare fish communities from all borrow areas based on numerical abundance of all species. Pairwise resemblance between fish communities was calculated using "relative absolute distance," or RAD (Ludwig and Reynolds, 1988). Unlike some resemblance measures, RAD exhibits lower sensitivity to large differences in numbers of abundant species and greater sensitivity to smaller differences in numbers of rarer species. Consequently, values better reflect overall differences in community composition rather than relative dominance by a few very abundant species. Values range from 0.00 (identical abundances of all species in both samples) to 2.00 (disparate abundances of all species in both samples). We used unweighted pair-group method of averaging, or UPGMA, to link progressively dissimilar borrow area communities into a dendrogram. Clusters were identified based on RAD < 1.00 (i.e., distance less than 50% of the maximum possible value based on those data). Clustering theory and techniques are described in Pielou (1984), Gaugh (1986), and Ludwig and Reynolds (1988).

We used cluster analysis to evaluate community composition relative to temporal differences, borrow area location, river connection, and physical habitat. Rotenone data were used to compare communities from three different CE districts; if clusters were formed by geographically proximate areas, then we conclude that longitudinal position along the river is of greater importance in determining community composition. If community composition is influenced primarily by temporal factors, two separate clusters, each consisting of all eight borrow areas from a single year will result. If community composition is influenced primarily by physical habitat (and if habitat has not changed appreciably since 1981), eight separate clusters should result, each consisting of two observations for a single borrow area during two different years. Seining data were used to compare shoreline assemblages from riverside (batture) and

landside (isolated) borrow areas; if two clusters comprised exclusively of batture and landside borrow areas resulted, we conclude that river connection is of greater importance than physical habitat.

RESULTS AND DISCUSSION

HSI Models

Outlying data points that obscured linear relationships were deleted prior to final model development. Abundance of evaluation species that obtain relative large sizes as adults (buffalo, channel catfish, and largemouth bass) were disproportionately high, depending on taxa, in at least one of three small (< 8 acres) borrow areas sampled in 1981 (borrow areas 7, 11, and 16). These fish may have been trapped during receding water levels, particularly buffalo in borrow area 7. These borrow areas were deleted resulting in statistically significant ($p<0.05$) regression models for buffalo, channel catfish, and largemouth bass. Multiple regression used 2 to 3 variables with R^2 values ranging from 0.35 for buffalo to 0.53 for largemouth bass (Table 3).

Mean depth was positively correlated to buffalo and largemouth bass abundance suggesting that deeper borrow areas provide greater habitat value for these species. Turbidity was positively correlated with buffalo abundance, indicative of high allochthonous inputs and primary productivity required to support large standing crops of this taxon. Bigmouth buffalo feed on zooplankton, black buffalo on benthic invertebrates, and smallmouth buffalo on detritus, algae, zooplankton, and benthic macroinvertebrates (Robison and Buchanan, 1988). Channel catfish and largemouth abundance were positively correlated with days flooded. Permanent waterbodies connected to main river channels, either continuously or during floods, function as important nursery and feeding areas for fishes (Beecher et al. 1977; Leitman et al. 1991).

Table 3. Regression equations for evaluation species developed from 1981 rotenone collections (Cobb et al. 1984) in Mississippi River borrow areas. Sample size (N) varied among taxa to resolve differences in outlying data points that obscured existing linear relationships or that created artificial trends in fish-habitat relationships not supported by majority of observations (see text for further explanation). Dependent variables calculated from the equation (Pounds/acre, Number/acre) are $\log_{10}+1$ transformed.

Species	N	Equation	R^2	Probability
Buffalo	22	Pounds/acre = 0.515(mean depth) + 0.038(turbidity) +0.512	0.35	0.02
Silversides	19	Number/acre = 0.0001(shoreline length) - 0.046(turbidity) + 3.081	0.52	0.003
Channel catfish	22	Pounds/acre = 0.00003(shoreline length) + 0.010(days flooded) - 0.003(Conductivity) + 1.058	0.46	0.009
Largemouth bass	22	Pounds/acre = 0.119(mean depth) + 0.008(days flooded) - 0.001(conductivity) +0.037	0.53	0.003
Warmouth	19	Number/acre = 0.0002(shoreline length) - 0.016(days flooded) + 0.003(conductivity) + 1.218	0.37	0.07

Consequently, connectivity of backwater habitats to rivers is an important aspect in river management (Amoros 1991). Conductivity, a measure of total dissolved solids, was negatively correlated with channel catfish and largemouth bass abundance. High conductivity often reflects poor water quality in agriculturally-drained watersheds.

Number per acre was used as the dependent variable for smaller taxa. Bi-variate plots of the size of a borrow area and fish abundance indicated that silversides and warmouth were substantially less abundant in large borrow areas (>35 acres) which contributed to non-significant models. Catch efficiency of small individuals may have been lower in larger borrow areas because of deeper water and the distraction of larger fish that often predominate during rotenone sampling. Consequently, borrow areas greater than 35 acres were deleted resulting in 19 areas being used to generate regression equations for silversides and warmouth.

Abundance of silversides and warmouth were positively correlated to shoreline length. Silversides are found in littoral and pelagic habitats, apparently migrating into shallow areas during the day, offshore into deeper water at nights (Mense 1967; Hubbs 1977). Silversides, which are sight feeders, were negatively correlated with turbidity. Warmouth, which were also negatively correlated with frequency of flooding, are typically found in shallow, isolated backwaters (Pflieger 1978; Robison and Buchanan 1986), suggesting that greater shoreline length and prolonged isolation from the mainstem river will provide greater amounts of preferred habitat. Also, islands and riparian plantings incorporated under the avoid/minimize plan will provide structural complexity, a habitat attribute preferred by warmouth and other wetland fishes.

Standard deviations of species abundance indicate high variability among borrow areas, even when outliers were removed (Table 4). Except for largemouth bass, evaluation species were not found in all borrow areas. Fluctuating hydroperiod may be one contributing factor. Connectivity with the river is an important attribute of floodplains and tends to promote high species richness (Baker et al. 1991). However, fluctuating stage elevations, including rapid isolation of a borrow area as stages decline after spring floods, may reduce the importance of habitat selection as fish attempt to follow the moving aquatic-terrestrial zone (Junk et al. 1988).

Table 4. Summary statistics for evaluation species based on 1981 rotenone collections in Mississippi River borrow areas (Cobb et al. 1984).

Species	Variable	N	Mean	Std. Dev.	Min	Max
Buffalo	No/acre	22	68.5	73.4	0	255
	Pds/acre	22	116.5	130.7	0	440
Silversides	No/acre	19	200.7	279.9	0	990
	Pds/acre	19	0.2	0.3	0	1.4
Channel catfish	No/acre	22	73.9	66.0	0	245
	Pds/acre	22	14.8	10.4	0	38
Largemouth bass	No/acre	22	27.8	26.5	1	95
	Pds/acre	22	5.8	4.7	0.1	15
Warmouth	No/acre	19	140.3	224.6	0	949
	Pds/acre	19	0.9	0.9	0	3.4

Abundance of evaluation taxa differed between years (Table 5). Buffalo and catfish biomass either increased or decreased with no consistent trends among areas. Silverside densities were lower in 1996-1997 in most borrow areas. In 1996-97, largemouth bass increased or was comparable to 1981. Warmouth abundance was greater in large borrow areas during 1996-97, but varied substantially among years in smaller borrow areas.

Empirically-derived multiple regression models offer several advantages over hypothetical models: identification of relevant variables, area-specific quantification of fish-habitat relationships, and statistical evaluation. Because habitat tolerances and affinities of fish are presumed fixed, such models should be broadly applicable. Fish abundance over time, however, is dynamic and likely to reduce predictive ability, particularly if a sufficiently broad range of fish densities and physical habitats were not incorporated into the original models. This is well-illustrated by the disparities between fish abundances observed in the borrow areas in 1996-97 and those predicted by models developed from 1981 data (Table 5) using surveyed morphometry data (Table 6). Abundance was substantially overestimated in some cases while there was high concordance in others.

Table 5. Comparison of number (no) or pounds (pds) per acre of evaluation species measured (M) during the summer in 1981 (Cobb et al. 1984) and 1996-97 (this study) for eight borrow areas in the lower Mississippi River. Predicted values (P) were calculated from regression equations (Table 3) using independent variables measured in 1996-97 (Table 6). Bayou Goula area was not sampled in 1981.

	New Orleans District					Vicksburg District		
Species	Borrow Area Number 25			Bayou Goula Area		Borrow Area Number 2		
	1981 M	1997 M	1997 P	1997 M	1997 P	1981 M	1996 M	1996 P
Buffalo, pds	64.0	227.5	>500	296.3	170.7	400.0	62.4	>500
Silversides, no	150	21	49.6	21	7.5	20	9	41.8
Channel catfish, pds	18.6	42.1	5.2	13.0	1.6	21.5	7.9	0.7
Largemouth Bass, pds	1.8	6.1	1.3	7.3	0.7	15.3	6.0	0.8
Warmouth, no	22	25	47.8	5	1.1	60	84	18.2

	Vicksburg District						Memphis District		
Species	Borrow Area Number 6			Borrow Area Number 9			Borrow Area Number 13		
	1981 M	1996 M	1996 P	1981 M	1996 M	1996 P	1981 M	1997 M	1997 P
Buffalo, pds	180.3	0.6	29.7	0	1.7	74.5	72.9	154.5	55.3
Silversides, no	990	40	50.6	220	45	2	50	29	>1000
Channel catfish, pds	25.5	2.3	0.8	2.8	9.2	0.7	3.7	10.9	2.4
Largemouth Bass, pds	11.9	71.8	0.5	0.1	0	0.25	4.1	3.0	0.4
Warmouth, no	211	33	3.9	75	517	2.7	129	153	>1000

	Memphis District					
Species	Borrow Area Number 15			Borrow Area Number 17		
	1981 M	1997 M	1997 P	1981 M	1997 M	1997 P
Buffalo, pds	112.1	57.7	>500	43.3	8.2	19.7
Silversides, no	12	35	1.5	300	110	72.2
Channel catfish, pds	12.4	1.4	2.0	7.9	0.06	1.0
Largemouth Bass, pds	5.6	8.8	0.6	0.45	10.7	0.4
Warmouth, no	37	147	354	52	277	273

Table 6. Comparison of mean values of morphometric and water quality variables for riverside borrow areas in the Mississippi River measured during summer of 1981 (Cobb et al. 1984), 1996, and, and 1997. Bayou Goula borrow area in the New Orleans District was not included because it was not sampled in 1981.

Variable	New Orleans		Vicksburg						Memphis					
	Number 25		Number 2		Number 6		Number 9		Number 13		Number 15		Number 17	
	1981	1997	1981	1996	1981	1996	1981	1996	1981	1997	1981	1997	1981	1997
Surface Area, acres	36.9	26.5	18.6	18.76	4.5	4.5	3.3	3.26	53.4	22.7	53.4	41.0	38.1	15.6
Mean Depth, ft	5.6	3.7	5.7	5.8	3.8	2.7	1.7	1.3	3.8	3.8	3.9	4.2	3.0	1.5
Maximum Depth, ft	10.3	7.1	10.4	10.7	6.0	5.3	3.5	2.6	16.9	12.4	7.5	6.1	5.7	2.6
Percent Area > 5 feet	66.9	26.7	71.0	53.8	55.5	0	1.6	0	30.9	21.7	44.6	25.0	21.9	0
Percent Area > 10 ft	7.6	0	21.4	5.1	0	0	0	0	8.3	18.0	0	0	0	0
Shoreline Length, ft	15,224	12,196	4,839	5336	5,737	3,135	1,916	1,751	14,008	20,297	8,881	12,626	10,498	10,015
Shoreline Development	3.4	3.2	1.5	1.7	1.5	2.0	1.4	1.3	2.6	5.8	1.6	2.7	2.3	3.5
Volume, yds^3	325,348	160,001	178,733	176,080	27,442[1]	19,708	9,780	7,075	309,178	131,476	348,228	170,985	183,100	23,624
Volume Development Index	1.6	1.6	1.6	1.6	1.9	1.6	1.5	1.6	0.7	0.9	1.6	2.0	1.6	1.8
Mean Basin Slope	0.07	0.10	0.05	0.048	0.02	0.001	0.03	0.012	0.05	0.012	0.02	0.0028	0.03	0.0025
Number of Days Flooded	81	114	71	66	89	80	84	62	56	82	56	82	25	46
Dissolved Oxygen, mg/l	5.2	4.1	5.6	5.3	4.2	5.6	10.2	11.6	8.9	7.3	5.6	8.2	9.5	3.6
pH	7.9	7.4	8.1	7.7	7.6	8.1	8.2	8.9	8.4	7.5	7.7	8.4	8.1	7.5
Conductivity, μmhos/cm	336	282	205	344	341	342	432	287	318	269	368	228	234	205
Water Temperature, °C	32	31.6	32	31	32	32	31	29	34	35	33	36	33	24
Turbidity, NTU	10	35	42	22	18	15	13	44	8	7	10	33	16	27

[1] Estimated by multiplying area by mean depth

Onset and magnitude of flooding in 1996-1997 may have influenced relationships between fish species composition and physical factors of the borrow areas during sampling. The entire batture land of the lower Mississippi River was flooded prior to the 1996-97 field sampling (Figure 1). Although the borrow areas were isolated during sampling, flooding was extensive in May and June 1996-97. Flooding also occurred in 1981, but the magnitude was substantially lower (Figure 1). Hydraulic mixing in the floodplain has been shown to obscure habitat-specific patterns of species abundance (Killgore and Baker 1996).

Habitat Units

Although single measures of abundance using rotenone may be inherently variable (Davies and Shelton 1983), the maximum value measured during the study provides an estimate of the upper limit (Table 4). These maximum values, when divided by values predicted from habitat variables for each alternative or plan (Table 1) using regression equations (Table 3), provided HSI scores ranging from 0.29 to 1.0 (Table 5). However, the majority of HSI values were high indicating the important habitat value of borrow areas to fishes of the lower Mississippi River system.

Habitat Units increased or remained the same for Plans 3 and 4 indicating that the MRL project will improve habitat for aquatic species (Table 7). Creation of permanent, riverside borrow areas will result in HU gains ranging from 57 to 34,456. In the New Orleans District, Plans 3 and 4 had the same gains in HU's because of engineering constraints. The narrow batture in the New Orleans District require relatively small, rectangular borrow areas. In the Vicksburg District, Plan 3 had the greatest increase in HU's due to the high number of borrow areas that would be created. However, cumulative HSI value for all species showed that the large, deep borrow areas constructed using the avoid/minimize plan provide approximately 1.5 times the habitat value per acre than that of the traditional plan or no action alternative. No permanent aquatic borrow areas will be created in the Memphis District under Plan 3, but a gain of 213 HU's will occur for the avoid/minimize plan.

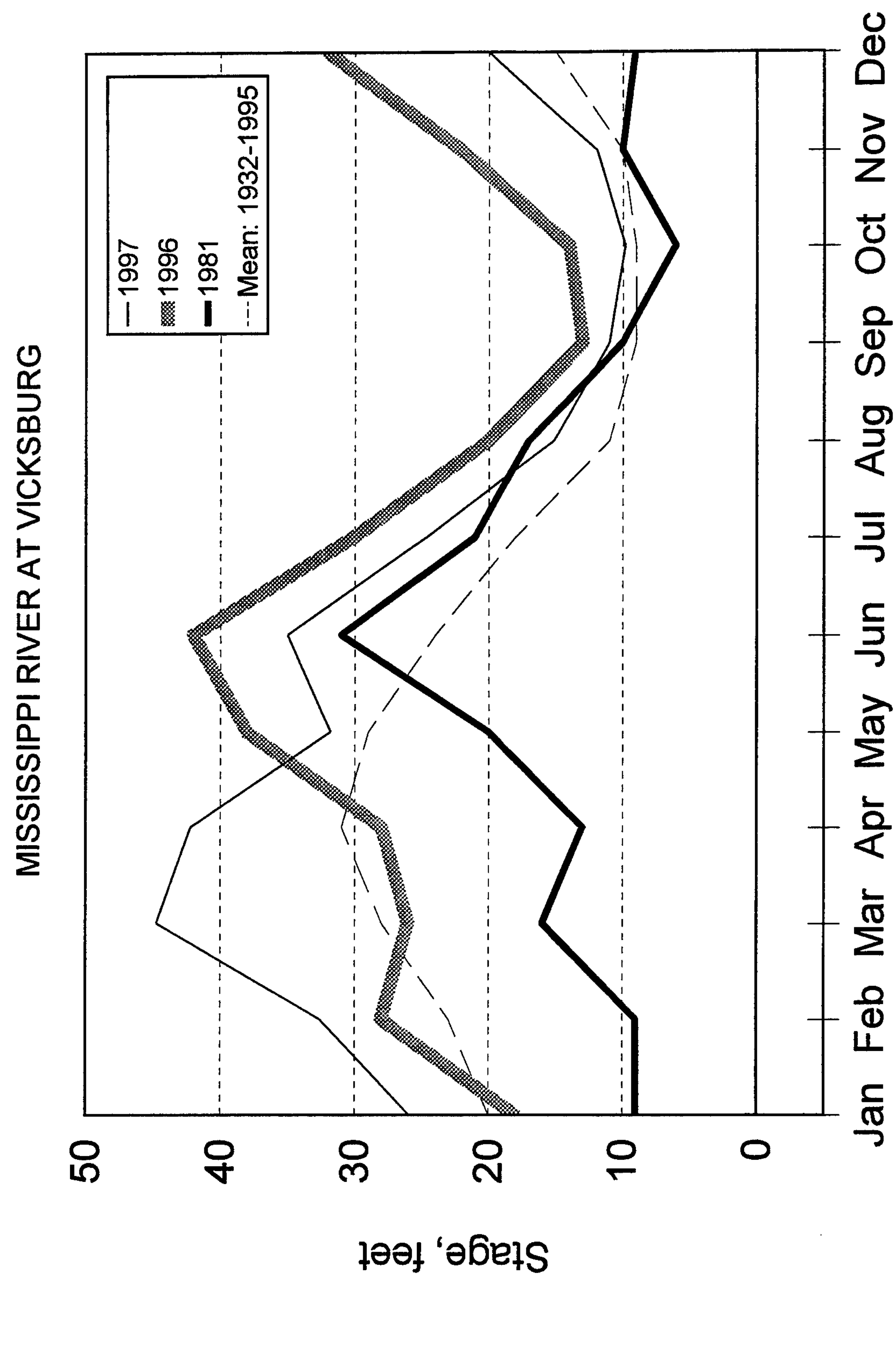

Figure 1. Average monthly stage elevation of the Mississippi River at Vicksburg, MS

Table 7. HSI values and Habitat Units for evaluation species by alternative. Habitat Units for traditional and avoid/minimize plans are in addition to that of no action (existing) alternative.

Evaluation Species	No Action Alternative			Structural Alternative					
				Plan 3: Traditional			Plan 4: Avoid and Minimize		
	HSI	Acres	HU	HSI	Acres	HU	HSI	Acres	HU
NEW ORLEANS DISTRICT									
Buffalo	0.71	2939	2087	0.96	16.6	16	0.96	16.6	16
Silversides	0.56	2939	1646	0.43	16.6	7	0.43	16.6	7
Channel catfish	0.80	2939	2351	0.73	16.6	12	0.73	16.6	12
Largemouth bass	0.90	2939	2645	1.00	16.6	17	1.00	16.6	17
Warmouth	0.80	2939	2351	0.29	16.6	5	0.29	16.6	5
Cumulative for species	3.77	2939	11080	3.48	16.6	57	3.48	16.6	57
VICKSBURG DISTRICT									
Buffalo	0.52	5794	3013	0.52	11800	6136	0.97	6650	6450
Silversides	0.46	5794	2665	0.46	11800	5428	0.70	6650	4655
Channel catfish	0.70	5794	4056	0.70	11800	8260	0.94	6650	6251
Largemouth bass	0.62	5794	3592	0.62	11800	7316	1.00	6650	6650
Warmouth	0.62	5794	3592	0.62	11800	7316	1.00	6650	6650
Cumulative for species	2.92	5794	16918	2.92	11800	34456	4.61	6650	30656
MEMPHIS DISTRICT									
Buffalo	0.46	1340	616	0.46	0	0	1.0	60	60
Silversides	0.51	1340	684	0.51	0	0	0.41	60	25
Channel catfish	0.76	1340	1018	0.76	0	0	0.66	60	40
Largemouth bass	0.51	1340	684	0.51	0	0	1.0	60	60
Warmouth	0.81	1340	1085	0.81	0	0	0.47	60	28
Cumulative for species	3.05	1340	4087	3.05	0	0	3.54	60	213

In the New Orleans and Memphis Districts, decreased shoreline length under Plan 4 reduced HSI values for silversides, channel catfish, and warmouth. However, environmental features incorporated in the avoid/minimize borrow areas, that include irregular shoreline, shallow and steep sides, islands, and possible plantings of riparian vegetation, insures gains in HU's for all three Districts. Sabo and Kelso (1991) reported that excavated floodplain borrow areas along the Mississippi River with long, sinuous shorelines, high volumes, and variable depths had high ichthyoplankton densities. Similarly, the avoid/minimize alternative will create relatively deep borrow areas with structurally complex littoral zones which is positively related to increased abundance of evaluation species.

The life of the project is 100 years, but length of construction period is different for each District: New Orleans - 2005 (8 years), Vicksburg - 2020 (23 years), Memphis- 2014 (17 years). Habitat Units were annualized to incorporate changes in borrow area acreage during construction (USFWS 1980). We assumed that borrow area acreage would increase linearly during the period of construction, and would remain the same for the life of the project (Figure 2). Based on these assumptions and using HSI values cumulative for all evaluation species (Table 4), Average Annual Habitat Units (AAHU's) gained in the lower Mississippi River for traditional and avoid/minimize plans were 30,549 and 27,381, respectively (Table 8). In the Vicksburg District, the traditional plan would create more borrow areas and have a larger gain in AAHU's than the avoid and minimize plan. However, the habitat value per acre is greater for the avoid and minimize plan in all Districts.

Table 8. Average Annual Habitat Units for the structural alternative by District and cumulative for the project area

District	Gain in Average Annual Habitat Units	
	Traditional: Plan 3	Avoid and Minimize: Plan 4
New Orleans	55	55
Vicksburg	30,494	27,131
Memphis	0	195
Lower Mississippi River	30,549	27,381

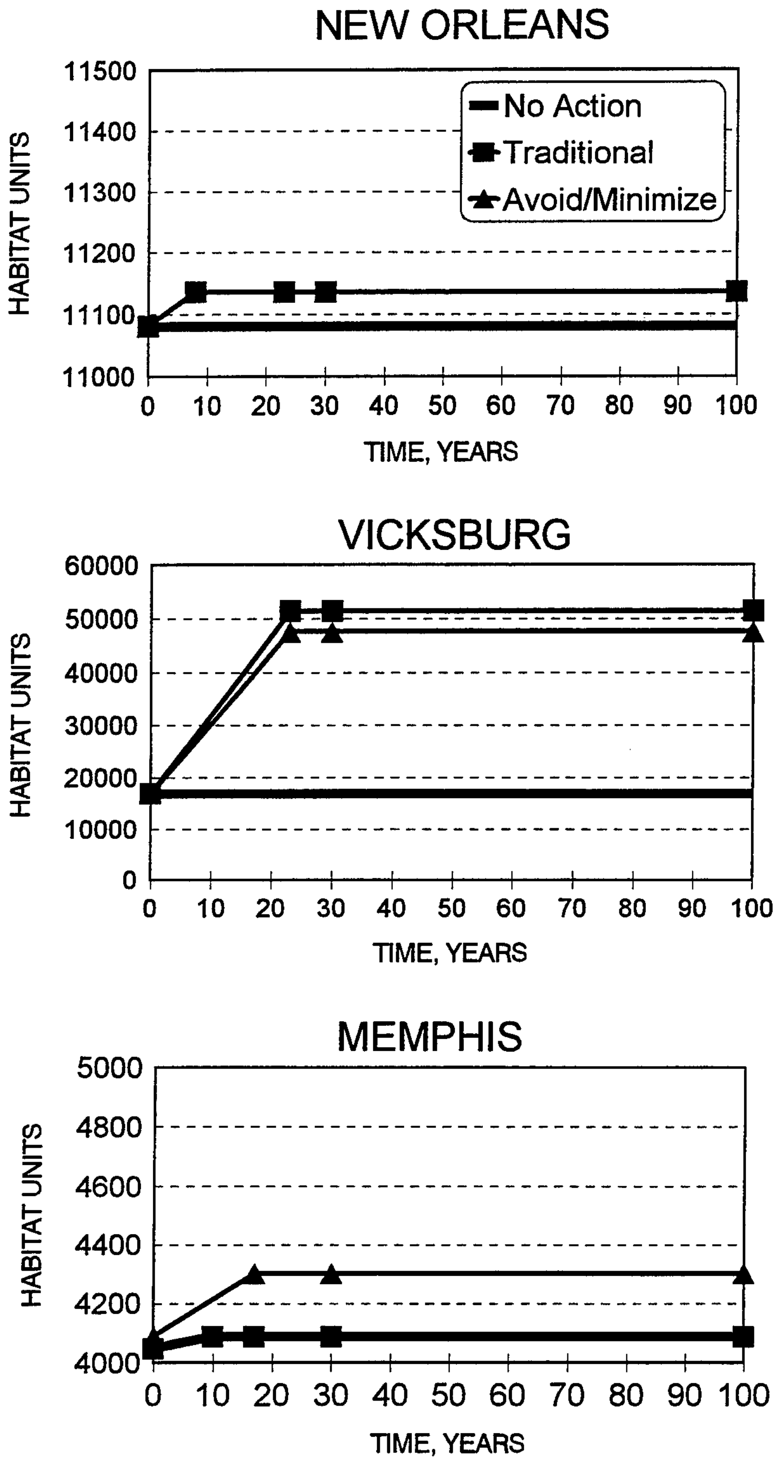

Figure 2. Habitat Units for no action alternative, and traditional and avoid/minimize plans. Life of the project is 100 years which includes a construction period.

Taxonomic Composition of the Fish Community

Sixty-seven species of fish were collected from borrow areas in 1996 and 1997 (Tables 9-11). Taxonomically dominant groups were minnows (13 spp) and sunfishes (12 spp). Catfishes, suckers, and darters were only moderately speciose (5-6 spp.). Three species are giant Asian minnows, recently established in the United States: grass carp, silver carp, and bighead carp. Three species are euryhaline typical of coastal estuaries: sailfin molly, Gulf pipefish, and striped mullet.

Previously, 67 species were documented from borrow areas in the lower Mississippi Basin (Baker et al. 1991), but 13 of these were not observed in this study and an additional 13 were previously undocumented. Borrow area species not observed in this study are: chain pickerel, cypress minnow, river shiner, ribbon shiner, red shiner, weed shiner, quillback, highfin carpsucker, brown bullhead, blackspotted topminnow, flier, banded pygmy sunfish, and slough darter. These species, however, are all considered "rare" or "uncommon" except ribbon shiner and blackspotted topminnow which are considered "common" (Baker et al. 1991). Thirteen species newly reported for borrow areas in this study are: mooneye, blacktail shiner, silver chub, silvery minnow, grass carp, silver carp, bighead carp, sailfin molly, Gulf pipefish, slough darter, cypress darter, river darter, and mullet. None of these species were frequently encountered or collected in large numbers. The total of eighty fish species now known from borrow areas suggests an ichthyofauna second in diversity only to the lower reaches of tributary streams (Baker et al. 1991). Isolated (landside) areas however, are substantially less speciose (27 spp) than those that maintain seasonal riverine connections (67 spp.) (Tables 10 and 11).

Thirteen species are characteristic inhabitants of borrow areas, but an additional sixteen are apparently restricted to borrow areas with riverine connections. Five species were found in all borrow areas sampled: gizzard shad, threadfin shad, bigmouth buffalo, inland silverside, and orangespotted sunfish. Another eight species were found in at least two borrow areas: spotted gar, common carp, western mosquitofish, bluegill, largemouth bass, white crappie, black crappie, and drum. All are considered "moderately tolerant" to "tolerant" of degraded water quality and degraded physical habitat (Jester et al. 1992). Twelve species were found in most of the riverside borrow areas, but were absent from landside locations: longnose gar, silver chub, pugnose minnow, river carpsucker, yellow bullhead, tadpole madtom, pirate perch, blackstripe topminnow, brook silverside, dollar sunfish, redear sunfish, redspotted sunfish.

Table 9. Fishes of Mississippi River borrow areas collected by rotenone in summer 1996 and 1997. Values represent number/acre and are presented by District (MVN - New Orleans, MVK - Vicksburg, MVM - Memphis). Grand mean is the mean number/acre for all borrow areas combined.

Family/Species	MVN		MVK			MVM			Grand Mean
	Goula	25	2	6	9	13	15	17	
Family Polyodontidae									
Polyodon spathula, paddlefish				2		35	3		5.0
Family Lepisosteidae									
Lepisosteus oculatus, spotted gar	154	16	16	149	10	85	1	2	54.1
L. osseus, longnose gar	1	1	1		1		2		<1.0
L. platostomus, shortnose gar	4	6					1		1.4
L. spatula, alligator gar	1								<1.0
Family Amiidae									
Amia calva, bowfin	4	7	5	9	1	3	20		6.1
Family Hiodontidae									
Hiodon alosoides, goldeye	2					29	1		4.0
Family Esocidae									
Esox americanus, grass pickerel						1		5	<1.0
Family Clupeidae									
Alosa chrysochloris, skipjack herring			7			1			1.0
Dorosoma cepedianum, gizzard shad	669	7920	5331	8074	423	4091	947	924	3547.6
D. petenense, threadfin shad	820	13329	99	252	8	3542	132	881	2382.8
Dorosoma sp., young-of-year shad							2544		318.0
Family Cyprinidae									
Cyprinus carpio, common carp	13	9	7		2	18	14		7.9
Ctenopharyngodon idella, grass carp		2							<1.0
Cyprinella venusta, blacktail shiner						2			<1.0
Hybognathus nuchalis, silvery minnow						1			<1.0
Hypophthalmichthys molitrix, silver carp		1							<1.0
Hypophthalmichthys nobilis, bighead carp		2	3	9					<1.0
Macrhybopsis storeriana, silver chub	6	1			11		1		2.5
Notemigonus crysoleucas, golden shiner		2	1	13		6	14	160	64.3
Notropis atherinoides, emerald shiner			3				1		<1.0
N. maculatus, taillight shiner			21	21			1	863	109.7
N. shumardi, silverband shiner			1			2	3		1.0
Opsopoeodus emiliae, pugnose minnow	45	8				4	33	964	137.0
Pimephales vigilax, bullhead minnow	6					25			4.0
Notropis sp., unidentified minnows	1								<1.0
Family Catostomidae									
Carpiodes carpio, river carpsucker	1	1	1			5	1	2	1.4
Ictiobus bubalus, smallmouth buffalo	32	47	17	7	4	22	32	11	21.5
I. cyprinella, bigmouth buffalo	61	49	13	5	14	24	20	6	23.4
I. niger, black buffalo	20	7	10	1	7	8	8	1	7.7
Ictiobus spp., young-of-year buffalo			1						<1.0
Minytrema melanops, spotted sucker				4					<1.0

Table 9. Continued.

Family/Species	MVN		MVK			MVM			Grand Mean
	Goula	25	2	6	9	13	15	17	
Family Ictaluridae									
Ameiurus melas, black bullhead	2	1		3	1	6	3		2.0
A. natalis, yellow bullhead	2		4	3	3	1	11	34	7.3
Ictalurus furcatus, blue catfish			1						<1.0
I. punctatus, channel catfish	32	123	322	25		37	14	2	69.4
Noturus gyrinus, tadpole madtom		2		2		29	47	2	10.3
Pylodictis olivaris, flathead catfish			2			1	2		<1.0
Family Aphredoderidae									
Aphredoderus sayanus, pirate perch	3	1		3		32	1	1	5.2
Family Cyprinodontidae									
Fundulus chrysotus, golden topminnow				24	2	35			7.6
F. dispar, starhead topminnow			1	1	18			12	1.5
F. notatus, blackstripe topminnow	1	1				68	22	50	20.3
Family Poeciliidae									
Gambusia affinis, mosquitofish	17	1	1	16	1	43	9	19	13.4
Family Atherinidae									
Labidesthes sicculus, brook silverside	5	10	4		20		27		8.3
Menidia beryllina, inland silverside	16	11	5	40	25	29	8	110	30.5
Family Percichthyidae									
Morone chrysops, white bass		14	12	8	8	48	30		15.0
M. mississippiensis, yellow bass	13	13	60	63	1	15	68	2	29.4
Family Centrarchidae									
Lepomis cyanellus, green sunfish	14	14	12			64	2	20	15.7
L. gulosus, warmouth	5	25	84	33	517	152	147	277	155.0
L. humilis, orangespotted sunfish	430	126	409	109	23	482	651	383	326.6
L. macrochirus, bluegill	84	384	335	638	972	1123	267	3351	894.3
L. marginatus, dollar sunfish			38	2	18	1	28	16	12.9
L. megalotis, longear sunfish	5	11	12			448			59.5
L. microlophus, redear sunfish	4	1	1	169	260	2	13	169	77.4
L. miniatus, redspotted sunfish	40	5		2		1	2	3	6.6
L. symmetricus, bantam sunfish			1	26	60	1	1	130	27.4
Lepomis spp., young-of-year sunfishes	29	718	167	787	2347	493	2048	7047	1704.5
Micropterus salmoides, largemouth bass	16	27	61	120	341	155	97	119	117.0
Pomoxis annularis, white crappie	144	122	152	93		214	165	15	113.1
P. nigromaculatus, black crappie	73	35	66	172	254	14	22	88	90.5
Family Percidae									
Etheostoma asprigene, mud darter			1			21	3	1	3.3
E. chlorosomum, bluntnose darter							2	1	<1.0
E. proeliare, cypress darter				2					<1.0
Percina caprodes, logperch	1		6			1	1		1.1
P. shumardi, river darter						1		1	<1.0
Stizostedion canadense, sauger			4	4	1	3			1.5

Table 9. Concluded.									
Family/Species	MVN		MVK			MVM			Grand Mean
	Goula	25	2	6	9	13	15	17	
Family Sciaenidae Aplodinotus grunniens, freshwater drum	110	121	376	320	11	216	38	41	154.1
Family Mugilidae Mugil cephalus, striped mullet	2								<1.0
Total Number of Individuals	2888	23173	7674	11326	5364	11640	7508	15713	
Total Number of Species	38	38	41	36	29	48	46	35	
Species richness ($E[S_{2000}]$)	36	21	30	28	27	35	42	27	
Shannon function	1.82	1.76	1.31	1.10	2.03	1.95	2.20	2.20	
Evenness	0.66	0.66	0.35	0.33	0.69	0.65	0.69	0.72	

Table 10. Fishes of riverside and landside borrow areas along the lower Mississippi River collected by seining in summer 1997. Values represent number collected per 10 seine hauls.

Family/Species	Riverside Borrow Areas						Landside Borrow Areas				
	13	15	17	25	Goula	Mean	1	2	3	4	Mean
Family Lepisosteidae											
Lepisosteus osseus, longnose gar		2				0.4					
Family Amiidae											
Amia calva, bowfin		2				0.4					
Family Clupeidae											
Dorosoma cepedianum, gizzard shad		1	11	134	6	30.4	10	14	1	9	8.5
D. petenense, threadfin shad		107	20	1329	1176	526.4	1		11	21	8.2
Family Cyprinidae											
Cyprinus carpio, common carp		1				0.2					
Macrhybopsis storeriana, silver chub		1		22	11	6.8					
Notemigonus crysoleucas, golden shiner		20	3			4.6	110		2		28.0
N. maculatus, taillight shiner			88			17.6					
N. shumardi, silverband shiner		3				0.6					
Opsopoeodus emiliae, pugnose minnow		54	34	424	292	160.8					
Pimephales vigilax, bullhead minnow	1			11	27	7.8					
Family Catostomidae											
Ictiobus bubalus, smallmouth buffalo	1			4	3	1.6					
I. cyprinella, bigmouth buffalo				1		0.2	2				0.5
Family Ictaluridae											
Ameiurus melas, black bullhead							4		1		1.2
I. punctatus, channel catfish		1	1	26		5.6	1			8	2.2
Noturus gyrinus, tadpole madtom	4					0.8					
Family Aphredoderidae											
Aphredoderus sayanus, pirate perch	1	1		4		1.2					
Family Cyprinodontidae											
Fundulus chrysotus, golden topminnow	21					4.2			37		9.2
F. dispar, starhead topminnow			3			0.6					
F. notatus, blackstripe topminnow	10	3	2		45	12.0					
Family Poeciliidae											
Gambusia affinis, western mosquitofish	27		9	329	411	155.2		3	1	24	7.0
Poecilia latipinna, sailfin molly				7		1.4					
Family Atherinidae											
Menidia beryllina, inland silverside	22		8	204	181	83.0	4	251	26	1	70.5
Familiy Synganthidae				1	1	0.4					
Syngnathus scovelli, Gulf pipefish											
Family Percichthyidae											
Morone chrysops, white bass								1			0.2
M. mississippiensis, yellow bass				5		1.0					

Table 10. Concluded.											
Family/Species	Riverside Borrow Areas						Landside Borrow Areas				
	13	15	17	25	Goula	Mean	1	2	3	4	Mean
Family Centrarchidae									2		0.5
Lepomis cyanellus, green sunfish				17		3.4					
L. gulosus, warmouth	37	26	12	12	9	19.2	2	371	6	334	178.5
L. humilis, orangespotted sunfish		58	9	1048	152	253.4	38	79	118		58.7
L. macrochirus, bluegill	116	122	87	31	579	189.0					
L. megalotis, longear sunfish	6			16	67	17.8					
L. microlophus, redear sunfish		16	29			9.0					
L. miniatus, redspotted sunfish	4					0.8			1		0.2
L. symmetricus, bantam sunfish	7		62			13.8	28	4	372		101.0
Micropterus salmoides, largemouth bass	41	24	4	7	14	18.0					
Pomoxis annularis, white crappie		17	1	11	14	8.6			1	60	15.2
P. nigromaculatus, black crappie		8	2	8	7	5.0					
Family Percidae											
Etheostoma asprigene, mud darter		3				0.6					
E. chlorosomum, bluntnose darter		3		1		0.8					
Family Sciaenidae											
Aplodinotus grunniens, freshwater drum		2		2	1	1.0				5	1.2
Total Number of Individuals	298	475	385	3654	2996	1561.6	199	724	579	462	491.0
Total Number of Species	14	22	18	24	18	19.2	9	8	13	8	9.5
Species richness ($E[S_{85}]$)	11	13	13	10	10		8	5	7	6	
Shannon function	1.95	2.20	2.20	1.76	1.82	1.99	1.35	1.10	1.14	1.00	1.15
Evenness	0.65	0.69	0.72	0.66	0.66	0.68	0.62	0.77	0.55	0.48	0.60

Table 11. Fishes of riverside and landside borrow areas along the lower Mississippi River collected by gill nets in summer 1997. Values represent number collected in six gill nets set overnight.

Family/Species	Riverside Borrow Areas						Landside Borrow Areas				
	13	15	17	25	Goula	Mean	1	2	3	4	Mean
Family Polyodontidae											
Polyodon spathula, paddlefish	3	1				0.8				1	0.2
Family Lepisosteidae											
Lepisosteus oculatus, spotted gar	13	29	18	7	11	15.6	9	2		4	3.7
L. platostomus, shortnose gar				2	2	0.8					
L. spatula, alligator gar				1		0.2					
Family Amiidae											
Amia calva, bowfin	1	14	7	1	4	5.4		6			1.5
Family Hiodontidae											
Hiodon tergisus, mooneye	6					1.2					
Family Clupeidae											
Dorosoma cepedianum, gizzard shad	20	18	3	23	34	19.6	23	20	1	12	14.0
D. petenense, threadfin shad	2					0.4	4				1.0
Family Cyprinidae											
Cyprinus carpio, common carp	5	47		5	2	11.8	13	4	1	3	5.2
Family Catostomidae											
Carpiodes carpio, river carpsucker	1					0.2					
Ictiobus bubalus, smallmouth buffalo	2	16		9	3	6.0				1	0.2
I. cyprinellus, bigmouth buffalo	3	4	3	14	8	6.4	2	4	1	14	5.2
I. niger, black buffalo		2	4	7	2	3.2			1		0.2
Minytrema melanops, spotted sucker			2			0.4					
Family Ictaluridae											
Ameiurus melas, black bullhead		1	2		1	0.8	4		1		1.2
A. natalis, yellow bullhead		1			1	0.4					
Ictalurus furcatus, blue catfish				1		0.2				1	0.2
I. punctatus, channel catfish	6	1		18	2	5.4		3		4	1.7
Pylodictis olivaris, flathead catfish	2					0.4					
Family Percichthyidae											
Morone chrysops, white bass				2		0.4					
M. mississippiensis, yellow bass		2		1		0.6	1				0.2
Family Centrarchidae											
L. gulosus, warmouth	3	4	1			1.6	4				1.0
L. macrochirus, bluegill		6				1.2	3				0.7
L. marginatus, dollar sunfish	3			1		0.8					
L. microlophus, redear sunfish		1				0.2					
Micropterus salmoides, largemouth bass	1	7	6			2.8	3	1	1		1.2
Pomoxis annularis, white crappie	2	2		3	3	1.8		3		6	2.2
P. nigromaculatus, black crappie		1		4	1	1.2		3			0.7
Family Percidae											
Stizostedion canadense, sauger	1					0.2					
Family Sciaenidae											
Aplodinotus grunniens, freshwater drum	4	3	2	4	1	2.8		2		4	1.5

Table 11. Concluded											
Family/Species	Riverside Borrow Areas						Landside Borrow Areas				
	13	15	17	25	Goula	Mean	1	2	3	4	Mean
Total Number of Individuals	78	161	48	103	74	92.8	66	48	6	50	42.5
Total Number of Species	18	19	10	17	14	15.6	10	10	6	10	9.0

Four additional species common in riverside borrow areas were found in very low numbers in a single landside borrow area: bowfin, smallmouth buffalo, black buffalo, and bantam sunfish (Tables 10 and 11). Eight of these 12 species are considered "moderately intolerant" to "intolerant" of degraded water quality or degraded habitat (Jenkins et al., 1992).

None of the species collected are federally listed as threatened or endangered, but several species found in riverside borrow areas are regionally imperilled (Robison and Buchanan 1988; Schmidt 1996). Paddlefish are listed by eight southern states, including Arkansas, are protected year-round in the state of Louisiana and seasonally in the state of Mississippi. Listing is proposed by the Committee on International Trade in Endangered Species (CITES) in 1998 (Cites 1997). Alligator gar have declined substantially during the past 40 years and are listed by the states of Tennessee and Arkansas. Tailight shiner typically occur in undisturbed oxbow lakes and swamps and are listed by the state of Arkansas. Golden topminnow, also an inhabitant of oxbows and swamps, are extirpated in Missouri and listed by the state of Tennessee. Borrow areas with riverine connections apparently function similarly to oxbow lakes, floodplain swamps, and seasonally inundated ponds. These habitats have declined 66-90% in the lower Mississippi Basin. Consequently, riverside borrow areas may provide alternate habitat for riverine and wetland species declining elsewhere in their range (Baker et al. 1991).

Similarity among borrow areas was only moderate overall, but higher among riverside areas than among landside areas (Table 12). Approximately half to three-quarters of all species occurring in any two riverside borrow areas occurred in both locations ($J = 0.51-0.71$). Borrow areas that were geographically proximate (13 and 15; Goula and 25) exhibited higher similarity ($J \geq 0.70$) than comparisons among borrow areas that were geographically disparate ($J < 0.60$). Approximately one third to half of all species occurring in any two landside borrow areas occurred in both locations ($J = 0.36-0.53$). Comparisons between riverside and landside borrow areas are probably not justified due to differences in sampling methodology (combined techniques vs

seining and gill netting only), but values suggest substantial differences in composition (J = 0.26-0.45) due to reduced diversity in landside borrow areas.

Table 12. Taxonomic similarity (Jaccard coefficients) of borrow area fish communities.

	#17	#13	#15	#9	#6	#2	Goula	#25	L-1	L-2	L-3	L-4
#17	-	0.64	0.68	0.52	0.68	0.55	0.54	0.57	0.33	0.32	0.35	0.27
#13		-	0.70	0.53	0.60	0.67	0.57	0.54	0.29	0.31	0.33	0.26
#15			-	0.56	0.64	0.71	0.67	0.65	0.30	0.33	0.32	0.28
#9				-	0.62	0.59	0.51	0.51	0.43	0.42	0.45	0.30
#6					-	0.57	0.53	0.53	0.32	0.38	0.33	0.32
#2						-	0.63	0.59	0.28	0.37	0.29	0.31
Goula							-	0.71	0.32	0.35	0.31	0.29
#25								-	0.31	0.33	0.30	0.28
L-1									-	0.45	0.50	0.40
L-2										-	0.41	0.53
L-3											-	0.36
L-4												-

Species-abundance of Fish in Borrow Areas

Data derived from rotenone, seine, and gill net samples indicated high variation in fish abundance, diversity, and community composition among borrow areas. Overall, fish are more abundant and diverse in riverside borrow areas than in landside areas, and diversity is higher in borrow areas located farther north (upstream).

Rotenone sampling - Sixty-four species were collected using rotenone, but 10 species comprised more than 90% of all fishes (Table 9). Abundant species were: gizzard shad (41.0%), threadfin shad (27.5%), bluegill (10.3%), orangespotted sunfish (3.8%), freshwater drum, warmouth, taillight shiner, pugnose minnow, largemouth bass, and white crappie (1.3-1.8%).

Diversity was higher in borrow areas located further upstream. Species richness was higher for Memphis District borrow areas # 15 and #13, ($E[S_{2000}] \geq 35$) than for Vicksburg District ($E[S_{2000}] = 27\text{-}30$) and for New Orleans District borrow area #25 ($E[S_{2000}] = 21$). Similarly, heterogeneity for the four uppermost borrow areas was higher (H' = 1.90-2.33) than for middle locations and lower borrow areas #2, #6, and #25 (H' = 0.96-1.31). Longitudinal trends in evenness were not apparent. The borrow area at Goula, which was only recently constructed, was exceptional for its low longitudinal position and high species richness ($E[S_{2000}] = 36$) and heterogeneity (H'=2.25). Species richness was lower in borrow area #17 ($E[S_{2000}] = 27$, a shallow site), compared to other upper borrow areas.

Rarefaction curves reflected longitudinal differences in diversity (Figure 3). Curve amplitudes (expected number of species for a range of subsample sizes) were higher for borrow areas 15 and 13, than for borrow areas 2, 6, and 9, all of which were substantially higher than the curve for borrow area 25. Left-hand side of curves were comparatively steep indicative of moderate evenness. Right-hand slopes indicated that additional species would be detected with additional sampling effort although scale of x-axis indicates that thousands more fish would have to be collected to detect a single new species.

Cluster analysis of rotenone data indicates high temporal and spatial variability in community composition (Figure 4). Similarity in community composition between sampling periods within individual borrow areas was high (mean RAD = 1.08, SD = 0.43). Between period similarity was greater for lower and middle borrow areas 25, 2, and 6 (RAD = 0.63-0.84), however, than for upper borrow areas 9, 11, 13, and 15 (RAD = 0.85-1.64). Similarity among borrow areas within sampling periods was comparable in 1981 (mean RAD = 1.01, SD = 0.47) and in 1996-1997 (mean RAD = 1.09, SD = 0.33). Very high similarity (RAD < 0.60) between different borrow areas, however, was observed among three pairwise comparisons in 1981 and among 2 comparisons in 1996-1997.

Four clusters were evident (Figure 4). One cluster of eight samples consisted of 1981 samples of borrow areas 2, 9, 13, 15, 17 and 1996-1997 samples of borrow areas 2, 6, and 15. Borrow areas 2 and 6, which are geographically proximate, exhibited the highest similarity in community composition (RAD = 0.29) observed among any two areas. A second cluster, consisiting of 1996-1997 samples of borrow areas 25, 13, and Goula and the 1981 sample from borrow area 6, was dissimilar to samples in the first cluster (RAD = 1.00).

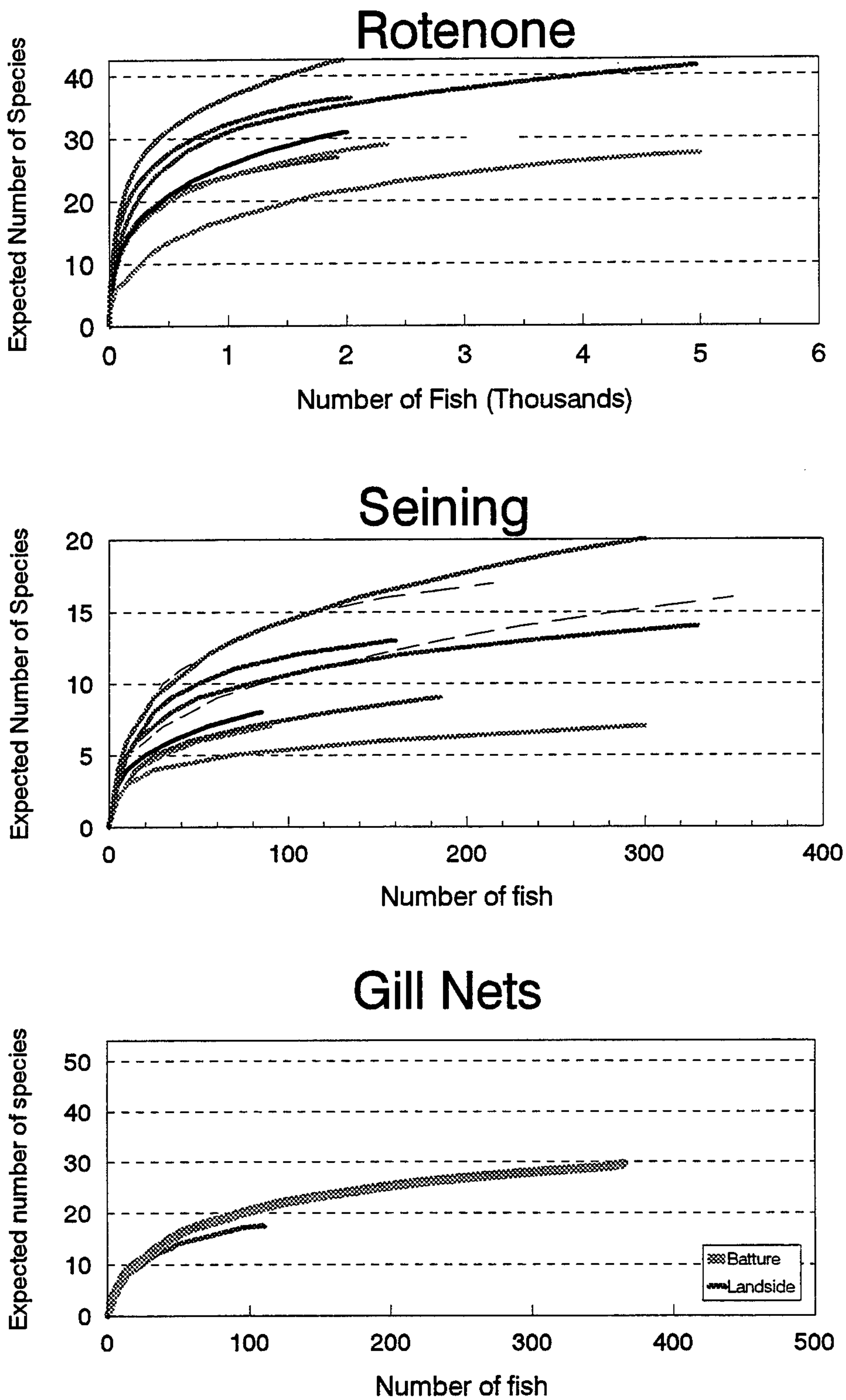

Figure 3. Rarefaction curves of borrow areas sampled in 1996-97 with rotenone, seines, and gill nets.

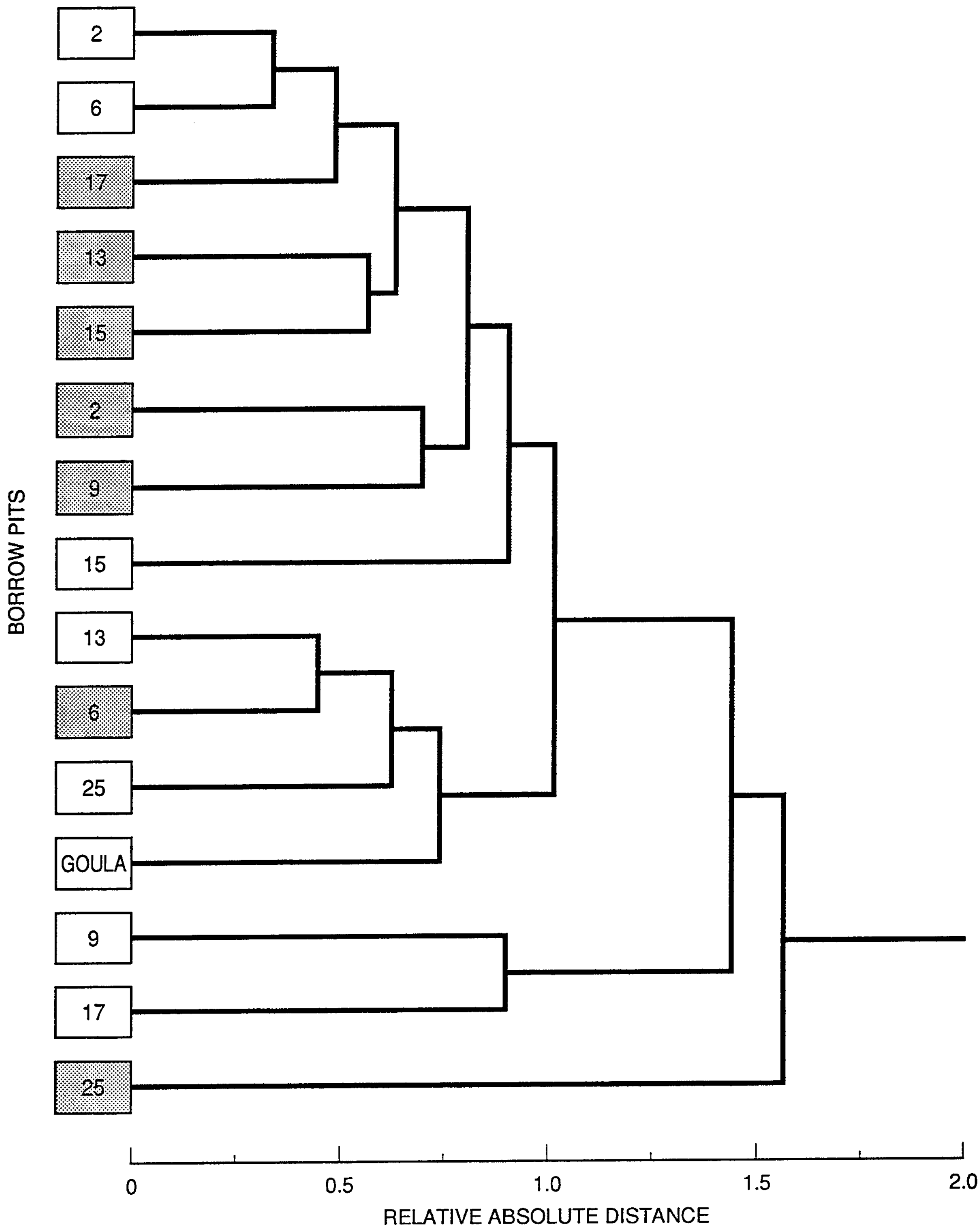

Figure 4. Dendrogram of fish community data from eight borrow areas rotenoned in 1981 (symbols shaded) and in 1996-97 (symbols open). Relative absolute distance (x-axis) indicates pairwise resemblance between fish communities; values range from 0.00 (identical abundances of all species in both samples) to 2.00 (disparate abundances of all species in both samples).

Distance measures among areas within clusters and distance between clusters were attributable to cumulative differences in abundances of ubiquitous species (shad, buffalo, bluegill, drum), but consistent trends in relative abundance of individual taxa could not be identified. A third cluster, consisting of samples from upper borrow areas 9 and 17 in 1996-1997, were highly dissimlar to borrow areas in the first two clusters (RAD = 1.43). Warmouth (> 270/acre), redear sunfish (≥ 169/acre), and bantam sunfish (> 60/acre) were more abundant in these samples than in any other, and white crappie least abundant (≤15 /acre). The 1981 sample from the lowermost borrow area (#25) was an outlier from all other samples (RAD = 1.56). Fish community was characterized by very high abundance of threadfin shad, and by the distinctive occurrence of euryhaline and exotic carp species.

Seining - Forty species were collected by seining (Table 10). Of these forty species, 38 were found in riverside borrow areas, 17 were found in landside areas. Eleven species comprised 94.1% of fishes found in riverside borrow areas: threadfin shad (33.7%), orangespotted sunfish (16.2%), bluegill (12.0%), pugnose minnow (10.3%), western mosquitofish (9.9%), inland silverside (5.3%), gizzard shad, warmouth, largemouth bass, longear sunfish, and taillight shiner (1-2%). Other species comprised less than 1% of fish collected. Ten species comprised 98.7% of all fishes collected from landside borrow areas: orangespotted sunfish (36.3%), largemouth bass (20.6%), inland silverside (14.4%), bluegill (12.0%), golden shiner (5.7%), white crappie (3.1%), golden topminnow, gizzard shad, threadfin shad, and western mosquitofish (1-2%). Other species comprised less than 1% of fish collected.

Diversity was high for upper riverside borrow areas, intermediate for lower riverside borrow areas, and low for landside areas. Species richness was highest for borrow areas 15 and 17 ($E[S_{85}] = 13$), lower for 13 ($E[S_{85}] = 11$); species richness was moderate for borrow areas 25 and Goula ($E[S_{85}] = 10$), low for landside borrow areas 1, 3, and 4 ($E[S_{85}] = 6$-8), and lowest for landside borrow area 2 ($E[S_{85}] = 5$) (Figure 3). Heterogeneity was consistently higher in riverside borrow areas (H' = 1.76-2.20) than in landside areas (H' = 1.00-1.35) (Table 9). Evenness was comparable in the majority of borrow areas (E = 0.62-0.77); it was comparatively low in landside borrow areas 3 and 4 (E ≤ 0.55). Further sampling of landside borrow areas may reveal additional exploitable species, such as redear sunfish, that have been stocked to provide a recreational fishery.

Cluster analysis indicated high variability among borrow areas (Figure 5). Only borrow areas 25 and Goula had similar fish assemblages (RAD = 0.62). These two areas had very high abundances of three species: threadfin shad (> 1100 CPUE), western mosquitofish (> 325 CPUE), and pugnose minnow (> 250 CPUE) compared with all other areas (< 110 CPUE), and moderate abundance of silver chub, bullhead minnow, and longear sunfish, which were rare or absent in other borrow areas. Borrow areas 15 and 17 were weakly associated (RAD =1.22) with areas 25 and Goula; they were also inhabited by moderate numbers of pugnose minnow (34 and 54 CPUE) and by black crappie not collected by seining in the other locations. All four borrow areas were inhabited by orangespotted sunfish, but numbers were low to moderate (9-152 CPUE) except in borrow area 25 in which they were disparately abundant (1048 CPUE). Landside borrow areas 2 and 4 had similar fish assemblages (RAD = 0.92), due chiefly to high abundance (> 330 CPUE) of orangespotted sunfish which were less abundant (< 155 CPUE) in all borrow areas except 25. Littoral zones of both locations were each inhabited by only 8 species, of which 3 co-occurred in both. Borrow area 13 and landside areas 1 and 3 were weakly associated (RAD = 1.28) partly due to very low abundances of orangespotted sunfish (0-6 CPUE), and to high numbers of largemouth bass (28-372 CPUE) compared with other locations (< 25 CPUE).

Gill netting - Thirty species were collected using gillnets, all of which occurred in riverside borrow areas, and 19 of which occurred in landside areas (Table 11). Ten species comprised 85% of fish collected from riverside borrow areas: gizzard shad (21.1%), spotted gar (16.8%), common carp (12.7%), bigmouth buffalo (6.9%), smallmouth buffalo (6.5%), bowfin and channel catfish (each 5.8%), black buffalo (3.4%), freshwater drum and largemouth bass (each 3.0%). Other species comprised less than 2.0% of fishes. Ten species comprised 89% of fish collected from landside areas: gizzard shad (32.9%), common carp (12.4%), bigmouth buffalo (12.4%), spotted gar (8.8%), white crappie (%.3%), channel catfish (4.1%), bowfin and freshwater drum (3,5%), black bullhead and largemouth bass (2.9%). Other species comprised less than 2.5% of fish.

Greater numbers of fish were collected in riverside borrow areas (48-161 CPUE) than in landside areas (6-66 CPUE), as were number of species (10-19 spp. and 6-10 spp respectively). Species richness was only slightly higher in riverside borrow areas ($E[S_{100}] = 20$) than in landside areas $E[S_{100}] = 17$), but curve slopes suggest that disparities in species richness would exist for subsamples > 300 (Figure 3). Species composition was similar for pelagic assemblages in riverside and landside borrow areas (RAD = 0.59). Gizzard shad were abundant ($\geq$ 14.0 CPUE)

and bigmouth buffalo moderately abundant ($\geq$ 5.2 CPUE) in riverside and in landside borrow areas. Differences in communities were attributable to larger numbers of spotted gar and common carp in riverside borrow areas ($\geq$11.8 CPUE) than in landside areas ($\leq$ 5.2 CPUE), and to exclusive occurrence of many comparatively rare (< 1 CPUE) species in riverside areas. These species were taxonomically dominated by lotic species: shortnose and alligator gars, river carpsucker, spotted sucker, flathead catfish, and sauger.

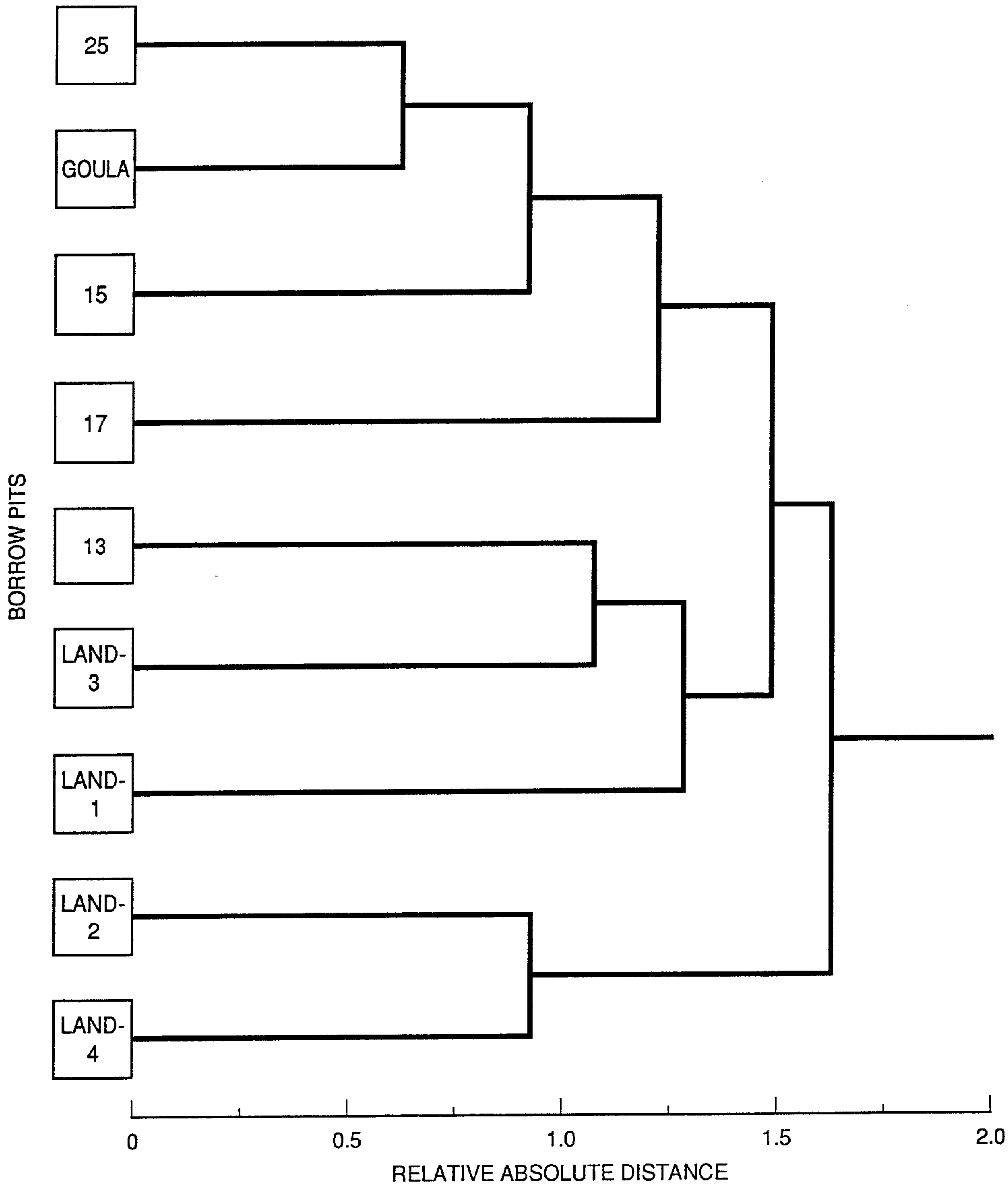

Figure 5. Dendrogram of fish community data from nine borrow areas seined in 1997. Relative absolute distance (x-axis) indicates pairwise resemblance between fish communities; values range from 0.00 (identical abundances of all species in both samples) to 2.00 (disparate abundances of all species in both samples).

CONCLUSIONS

1. Multiple regression models indicate that most riverine fishes benefit from borrow areas that are relatively deep (>5ft) and frequently flooded. Exceptions include warmouth, a wetland fish often found in shallow backwaters. Turbidity and conductivity may influence habitat quality for certain species, but the majority of existing borrow areas have suitable water quality to support a diverse assemblage of fish.

2. The avoid/minimize plan provided greater habitat value per acre of area for most exploitable and forage species (buffalo, largemouth bass, silversides), because deep borrow areas with sinuous shorelines will be created compared to shallower borrow areas that currently exist or would be created under the traditional plan. Many borrow areas gradually decrease in size and depth, and are colonized by BLH, so deep borrow areas are more likely to persist through the life of the project.

3. Borrow area fish community is speciose (67 spp.), but diversity of fish assemblages in riverside borrow areas is higher than those in landside areas.

4. Riverside borrow area communities include several uncommon and imperiled wetland species once characteristic of floodplain ponds (e.g., pugnose minnow, taillight shiner) and oxbow lakes (e.g., paddlefish, alligator gar).

5. Assemblages in individual riverside borrow areas exhibit only moderate similarity to each other qualitatively ($J = 0.51\text{-}0.71$) and quantitatively (mean $RAD_{1996\text{-}1997} = 1.09$, $SD=0.33$; mean $RAD_{1981}=1.01$, $SD=0.47$). Landside borrow areas are often managed for waterfowl or as a bass-bluegill fishery and contain many species that are tolerant of degraded conditions. Consequently, landside borrow areas constitute a depauperate subset of riverine species.

6. Relative abundance and community composition is highly variable among borrow areas and although correlated with specific habitat parameters, exhibits strong temporal variation. Frequency of flooding and hydraulic mixing during floods contribute to temporal variation.

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GLOSSARY OF SCIENTIFIC TERMS

cluster analysis - classification technique which arranges samples or communities into groups (clusters) based on their relative similarity to each other (Pielou, 1984). Cluster analysis calculates pairwise resemblance among all samples, using any of a wide variety of mathematical functions, and links samples agglomeratively from most similar to least similar, and is summarized as a dendrogram.

diversity - complexity of a biological community which may be expressed with a wide variety of mathematical functions (Magurran, 1988); functions respond to variation in species richness and/or species evenness and provide measure of uncertainty in predicting the species of any individual encountered at random from that community.

heterogeneity - diversity function incorporating measures of species richness and species evenness; the most commonly applied algorithm was developed by Shannon (1949).

multiple regression - interrelationship between a dependent variable and two or more independent variables that is expressed as a linear statistical model.

species richness - number of species documented in a sample or community (S), or, when determined by rarefaction, the expected number of species in a random subsample (y) of that community ($E[S_y]$).

species evenness - equitability of abundances among species within a sample or a community; indices of species evenness typically range from 0, when a single species is numerically dominant, to 1, when all species are equally abundant.

rarefaction (also "rarefraction") - technique for expressing species richness relative to the number of individuals in a community; rarefaction uses a factorial-based algorithm (Hurlbert 1971) to express number of species that would be expected from a random subsample of specified size

relative absolute distance (RAD) - Euclidean-based resemblance function that is standardized to differences in total organism abundance (Ludwig and Reynolds, 1988); when a pair of samples or communities is similar in composition, values for RAD will approach 0, when disparate in composition, RAD will approach 2.

APPENDIX 9
WATERFOWL ANALYSIS

A WATERFOWL TECHNICAL APPENDIX

for the

MISSISSIPPI RIVER MAINLINE LEVEE ENLARGEMENT PROJECT

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MAY 1998

EXECUTIVE SUMMARY

MISSISSIPPI MAINLINE LEVEE ENLARGEMENT PROJECT

WATERFOWL APPENDIX

This summarizes the findings contained in the U.S. Fish and Wildlife Service's (Service) Waterfowl Technical Appendix (appendix) associated with the Vicksburg District, U.S. Army Corps of Engineers (Corps) Mississippi River Mainline Levee Enlargement (MLE) project. It is the Service's understanding that this appendix is to become an integral part of any future planning documents.

Because of two consecutive years of exceptional breeding conditions, the 1997 estimate of total ducks is 31 percent above the long term average. Estimates for eight of the 10 principal species were above their long term averages, but two species (scaup and northern pintail) remain below their averages (Service 1997a). However, notwithstanding current breeding success, the loss and degradation of breeding and wintering habitat have been identified as the major waterfowl management problems in North America (Service and Canadian Wildlife Service 1986). Therefore, quantifying the impacts of the Mississippi mainline levee enlargement project to wintering waterfowl carrying capacity and foraging habitat in the project area, is the primary purpose of this appendix.

Using with and without hydrology modifications and land use data supplied by the Corps, the impact methodology for this appendix was based on food as an index of wintering waterfowl carrying capacity expressed in terms of number of duck-use-days (DUD). This methodology accounts for the effects of seed consumption and decomposition and evaluates available habitat flooded 24 inches deep or less. Preferred feeding habitat is equal to or less than 18 inches of water, however the Corps was only able to provide areas of habitat equal to or less than 24 inches deep. Project impacts in terms of losses of average seasonal acres flooded, during the 120 day wintering period from November 1 to February 28, were identified. Existing flooded habitat conditions were determined and compared to the impacts associated with Plan 3, the traditional levee enlargement and berm construction approach, and Plan 4, the avoid and minimize alternative.

Additionally, this appendix contains measures available to mitigate for the loss of duck-use-days. Conceptual in nature, the measures rely primarily on the acquisition and intense management of land for wintering waterfowl.

Implementation of the proposed MLE project would result in adverse impacts to migratory waterfowl wintering habitat. Losses would occur as a result of direct impacts to waterfowl foraging habitat being converted to borrow pits and berms. Annual waterfowl habitat carrying capacity would be reduced by 598,640 DUD with the traditional methods of levee construction (Plan 3) and 535,213 DUD with implementation of the avoid and minimize plan (Plan 4).

Compensation by the reforestation of lands with 70 percent mast producing trees would require 2,293 acres for Plan 3 and 1,429 acres for Plan 4. Mitigation lands could be reduced by approximately 611 acres with the consideration of the benefits of shallow waterfowl foraging areas created by construction of some of the borrow pits. The Service recommends that the mitigation area be a contiguous block preferably in the Yazoo backwater area at or below 90 feet NGVD.

The Service is concerned about the above described losses not only because of the adverse impacts to migratory waterfowl, a federal trust resource, but also because of the adverse, cumulative impacts to the Lower Mississippi Valley ecosystem.

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INTRODUCTION

This Waterfowl Technical Appendix (appendix) is submitted in partial fulfillment of the Fiscal Year 1997 scope of work for U.S. Fish and Wildlife Service (Service) activities pertaining to the U.S. Army, Corps of Engineers (Corps), Vicksburg District activities associated with the Mississippi River Mainline Levee Enlargement Project. The purpose of this appendix is threefold: first, to identify the relative importance of the general project area in terms of historic trends in wetlands and wintering waterfowl, primarily mallards (*Anas platyrhynchos);* secondly, to document baseline wintering waterfowl carrying capacity in the project area, and thirdly, to document project induced impacts to baseline conditions using food as an index of carrying capacity expressed in terms of duck-use-days.

The information contained in this appendix is submitted in accordance with the referenced scope of work and with provisions of the Fish and Wildlife Coordination Act, but does not constitute the final report of the Department of Interior, U.S. Fish and Wildlife Service, as required by Section 2(b) of the Act.

PROJECT DESCRIPTION

Prompted by major floods in the early 1900's and especially the disastrous flood of 1927, the flood of record, Congress passed the Flood Control Act of 1928 (FCA), authorizing the Mississippi River and Tributaries project (MR&T). The passage of this act initiated a direct federal role in flood control in the Delta. Subsequent flood control acts (1936, 1941, 1944, 1948, 1950, 1960) provided for flood control and improvement of specific tributaries of the Mississippi River.

In response to a June 12, 1954, Senate resolution, the Chief of Engineers, U.S. Army, Corps of Engineers (Corps) prepared a Comprehensive Review Report of the MR&T project. The report, which was released in December 1964, constituted a comprehensive review of the adequacy and feasibility of the flood control plan for the lower Mississippi River and its tributaries within the alluvial valley. The report recommended modification of the MR&T project to provide for authorization of additional improvements, including raising the height of the mainstem levees to suitable grade. As a result of this report, congress passed the FCA of 1965 authorizing additional work on specific tributaries of the Mississippi River, as well as upgrading the mainstem levees.

Following the flood of 1973, the Corps determined that the existing mainline levee system was insufficient to contain "the project flood." The project flood would be 11 percent greater than the 1927 flood at the mouth of the Arkansas River and 29 percent greater, or 3,030,000 cubic feet per second, at the Red River Landing, about 60 miles below Natchez (U.S. Army Corps of Engineers 1976). Based on data from flood events in 1973, 1974, and 1975, a new project design flow line was then established. As a result of this new flow line, the levees were reevaluated, deficiencies identified, and the design and construction of these deficient levees were initiated. To date

approximately 83 miles of levee have been raised. The Corps proposes to raise approximately 220 more miles of levees and construct 186 miles of seepage berms to control under levee seepage. Of the 220 miles of levees to be raised, approximately 20.6, 131.6, and 69.2 miles of levees would be raised in Arkansas, Louisiana, and Mississippi respectively.

PROJECT ALTERNATIVES

Plan 3 is the traditional method of levee construction, where borrow material to enlarge the levee and construct berms is obtained from the closest engineeringly feasible area, which is normally riverside of the worksite. This plan does not require special configuration or location of the borrow pits except for engineering purposes. No provisions are made to avoid wetland sites nor are design efforts made to provide drainage of these pits for reforestation or other environmental enhancement of the borrow pits. Traditionally designed borrow areas permanently hold water which is replenished periodically by normal river fluctuations.

Plan 4 is the alternate levee design developed by the Vicksburg District to avoid and minimize environmental damages to riverside woodlands and wetlands. Measures to reduce adverse impacts include (1) relocation of borrow areas from bottomland hardwoods to riverside prior converted farmlands or to cleared areas landside of the levee, and (2) the use of existing berm material to enlarge the levee and then replace the excavated berm with material dredged from the river. Another measure to reduce impacts will be the use of relief wells, which require much less land than berms, to control seepage under the levee. Further, instead of the straight line, fairly deep borrow pits that have been constructed in the past, environmental features including large shallow areas, irregular shorelines, and islands will be incorporated in many of the proposed pits. Some borrow areas will be shallow, provided with drainage, and reforested with bottomland tree species. Successful reforestation is dependent upon low water periods and favorable growing conditions.

HISTORICAL PERSPECTIVE OF WETLANDS AND WATERFOWL IN THE MAV

Wetlands

Before settlement by Europeans and Africans, the Mississippi River floodplain was an intricate maze of bottomland hardwood forests, swamps, and bayous covering approximately 24 million acres from Cairo, Illinois, to New Orleans, Louisiana. Today, only five million acres of forested wetlands remain. The primary reason that much of these forested wetlands have been lost is due to land clearing for agriculture made possible by federal flood control projects (U.S. Department of the Interior 1988). For instance, the MR&T mainline levee project has been responsible for the loss of millions of acres of forested wetlands within the MAV. The prevailing opinion of most experts on the Delta is that: 1) the natural topography alone does not provide much flood protection and 2) in the absence of the mainline levee system forest clearing and sustained cultivation of the Delta is impossible (U.S. Dept. of the Interior 1988). Galloway (1980) contends that in the absence of the federal program initiated in 1928 to rebuild and expand the mainline levees, clearing would have abated and the dominating hydrologic influence of the Mississippi River would have led to the ultimate reversion of most of the Delta to bottomland

hardwood forest.

Historically, most of the MAV was subject to periodic flooding by the Mississippi River and its tributaries. Hydrologic relationships in the MAV have been altered, however, by federally funded water resource developments for flood control and agriculture (Reinecke et al.1988). In western Mississippi, for example, the two year flood originally inundated more than 4.5 million acres. Construction of the mainstem Mississippi River levees reduced the two year flood to approximately one million acres (Galloway 1980). Thus, in western Mississippi alone, the cumulative impacts of the mainline levees have reduced the two year flood by about 88 percent (Reinecke et al.1989).

Waterfowl

Historically, the MAV served as a major wintering area for waterfowl. Waterfowl population numbers began to decline in the 1960's as the direct result of extensive droughts and loss of nesting habitat in the prairie pothole region of North America and the conversion of wintering areas in the MAV (bottomland hardwoods) to agricultural production. Recently, waterfowl populations have recovered to long term averages, primarily because of two years of exceptional breeding conditions. The net effect of wetland conversion and drainage has been that under normal conditions natural habitat is no longer sufficient to meet the needs of wintering waterfowl and other migratory birds.

However, the bottomland hardwoods that remain along the Mississippi River are among the nation's most important wetlands. Land cover information provided by Geographic Information System mapping of the batture lands (those lands riverside of the mainline levees) indicates that there is approximately 925,500 total acres within the Vicksburg District of which approximately 508,406 acres are bottomland hardwoods. These forested wetlands fulfill special waterfowl habitat requirements not provided by open lands. Wooded habitats produce nutritious foods for waterfowl and provide secure roosting areas, cover during inclement weather, loafing sites, protection from predators, and isolation for pair formation. Eight species of waterfowl regularly use bottomland hardwood forests, which are especially critical overwintering grounds for many North American waterfowl, including the 2.8 million mallards of the Mississippi Flyway, nearly all of the 1.7 million wood ducks, and many other migratory birds (Bellrose and Holm 1994).

Several species of waterfowl, including mallards (*Anas platyrhynchos)*, have recovered to the population levels recorded in the 1950's (Table 1). However two species, scaup (*Aythya affinis* and *A. marila*, combined) and the northern pintail (*Anas acuta*), remain below the long term average.

TABLE 1. BREEDING DUCK POPULATION ESTIMATES (in thousands) /1

YEARS	MALLARD	GADWALL	AMERICAN WIGEON	GREEN-WINGED TEAL	NORTHERN SHOVELER	NORTHERN PINTAIL	BLUE-WINGED TEAL
1955-60	9386	651	3195	1584	1556	8543	4909
1961-65	6062	928	2310	1228	1368	3514	3601
1966-70	7805	1641	2702	1652	2105	5177	4138
1971-75	8284	1544	2973	1873	2026	5968	4617
1976-80	7800	1457	3012	1651	1910	4891	4695
1981-85	5915	1483	2616	1612	1934	3240	3645
1986-90	5932	1443	2002	1860	1789	2334	3584
1991	5445	1584	2254	1558	1716	1803	3764
1992	5976	2033	2208	1773	1954	2098	4333
1993	5708	1755	2053	1694	2046	2053	3193
1994	6980	2318	2382	2108	2912	2972	4616
1995	8269	2836	2614	2301	2855	2758	5140
1996	7941	2984	2271	2500	3449	2736	6407
1997	9940	3897	3118	2507	4120	3558	6124

/1 U.S. Fish and Wildlife Service 1997a.

While the annual breeding bird surveys are the most reliable estimates of waterfowl populations, population estimates are also available from extensive surveys of wintering ducks as well as waterfowl harvest data. Conducted in January each year by the Service and the states, the midwinter survey is an attempt to count the total number of ducks of each species (Tables 2, 3, and 4). The resulting population estimates are not considered of sufficeint reliability to measure trends in abundance of most duck species because of the large area which must be surveyed and the difficulty of counting birds, especially in wooded habitats, and the lack of a valid statistical sampling scheme. These surveys do provide useful, general information on wintering waterfowl population levels. Additionally, comparing statewide numbers from year to year does not account for natural catastrophes such as droughts or excessive rainfall; factors known to influence the arrival and departure of wintering waterfowl. Therefore, these surveys tend to count fewer ducks than are actually present, but the amount of undercount is unknown and is likely variable from year to year.

Waterfowl harvests have fluctuated since records have been kept, being lowest during the early 1960's when populations, potential hunters, and days afield were low. In most years, harvests have tracked the fluctuation of these factors, especially populations. In recent years, as total duck populations have increased, nationwide harvests of the popular mallard (approximately 35 percent of the bag) and all other ducks have increased, while hunter success and hunter numbers have also increased. Nationwide, in 1996, approximately 1.3 million duck hunters harvested 13,876,800 ducks, with an average bag of nine ducks per hunter. In the Mississippi Flyway, approximately 625,000 hunters harvested 6,914,000 ducks during 6,985,000 hunter-days, with an average bag of 9.8 ducks (Service 1997b).

WINTERING WATERFOWL BIOLOGICAL CHARACTERISTICS

Habitat Requirements

The loss and degradation of habitat have been identified as the major waterfowl management problem in North America (Service and Canadian Wildlife Service 1986). Habitat requirements for wintering waterfowl can be broken down into three components: availability, utilization, and suitability in meeting social behavioral requirements. Size of the migratory waterfowl population in the MAV is a direct function of these three components. Managed and unmanaged wintering waterfowl habitats are present in the MAV. Managed habitats, using structural measures and vegetation manipulation, are primarily found on federal and state lands, and represent the core wintering habitat during dry (below normal rainfall) years. Since 1988, Ducks Unlimited, the U.S. Fish and Wildlife Service's Private Lands Program, and state partners programs (comprised of the U.S. Fish and Wildlife Service; Delta Wildlife Foundation; Arkansas Game and Fish Commission; Mississippi Department of Wildlife, Fisheries and Parks; and Louisiana Department of Wildlife and Fisheries) have provided assistance to hundreds of private land owners to manage 140,620 acres (41,795 acres in Arkansas, 27,259 acres in Louisiana, and 71,566 acres in Mississippi) as winter waterfowl habitat.

Temporary and seasonal wetlands tend to be large producers of waterfowl food supplies. Unmanaged winter habitat provides important foraging habitat to wintering waterfowl during years of normal or above normal rainfall. These periods of above normal rainfall show increases

TABLE 2. MIDWINTER WATERFOWL SURVEY FOR ARKANSAS (in thousands) /1

YEARS	MALLARD	GADWALL	AMERICAN WIGEON	GREEN-WINGED TEAL	NORTHERN SHOVELER	NORTHERN PINTAIL
1971-1975	4,425	122	109	29	21	334
1976-1980	2,783	40	53	34	8	96
1981-1985	2,614	104	119	34	44	137
1986-1990	3,873	286	92	228	51	212
1991	1,480	222	47	62	41	496
1992	439	30	7	26	9	28
1993	440	93	21	77	24	101
1994	508	61	11	119	39	99
1995	587	69	10	54	24	89
1996	581	78	15	59	18	59

/1 Gamble 1989, 1990, 1991, 1992,1995, 1996

TABLE 3. MIDWINTER WATERFOWL SURVEY FOR MISSISSIPPI (in thousands) /1

YEARS	MALLARD	GADWALL	AMERICAN WIGEON	GREEN-WINGED TEAL	NORTHERN SHOVELER	NORTHERN PINTAIL
1971-1975	343	4	11	5	2	22
1976-1980	272	8	11	11	2	14
1981-1985	184	15	12	4	10	8
1986-1990	133	11	8	6	23	7
1991	144	22	6	12	6	25
1992	126	14	7	16	4	15
1993	191	27	9	18	10	8
1994	174	43	15	27	9	23
1995	146	21	9	33	6	7
1996	127	11	7	36	6	10
1997	125	22	5	17	8	5

/1 Gamble 1989, 1990,1991, 1992,1995,1996

TABLE 4. MIDWINTER WATERFOWL SURVEY FOR LOUISIANA (in thousands) /1

YEARS	MALLARD	GADWALL	AMERICAN WIGEON	GREEN-WINGED TEAL	NORTHERN SHOVELER	NORTHERN PINTAIL
1971-1975	390	757	248	733	192	455
1976-1980	837	812	206	692	142	488
1981-1985	423	606	133	450	130	687
1986-1990	528	678	150	436	153	390
1991	397	607	177	662	207	275
1992	432	870	311	884	174	468
1993	137	67	31	211	25	88
1994	446	1,123	372	1,018	190	409
1995	574	1,623	300	700	306	416
1996	906	1,531	318	887	154	545

/1 Gamble 1989, 1990,1991,1992,1995,1996

in available foraging habitat from 900 percent in Mississippi to 1,200 percent in Arkansas (Reinecke et al. 1988). The increased availability of wintering habitat also effects the distribution of wintering waterfowl in the MAV. Proportionately more waterfowl have been found to winter in the MAV during periods of above normal rainfall and cold winters (Nichols et al. 1983, Reinecke et al. 1987). This unmanaged and flood susceptible habitat, which is so important to wintering waterfowl, has long been subject to federal flood control projects in the MAV. The Mississippi River Levee Enlargement project will adversely impact this type of winter waterfowl foraging habitat.

In recent years, research has focused on relative waterfowl utilization and associated food availability, in natural and agricultural foraging habitat. Utilization of agricultural fields differs among crops (Twedt and Nelms in prep). Herbaceous native vegetation is used to a greater extent than any agricultural crop. Bottomland hardwoods are used for foraging to a certain extent and roosting, loafing, and pair formation to a large extent (Reinecke et al. 1989). (Caloric values, seed consumption, and seed decomposition rates of available waterfowl foraging habitat form the basis for determining project impacts and are discussed in detail in the Impact Assessment Methodology section of this appendix.)

Habitat Utilization

Waterfowl are mobile and opportunistic, and their feeding habits have changed over time, presumedly in response to the large scale conversion of native wooded wetlands to pastures and small grain agricultural lands. Depending upon the location and the year, the principal foods of mallards generally include agricultural grains; seeds and tubers of native soil plants; acorns; and invertebrates such as isopods, snails, and fingernail clams (Reinecke et al. 1987). Heitmeyer (1985) and Combs (1987) found that pin oak (*Quercus palustris*) and cherrybark oak (*Quercus falcata* var. *pagodaefolia*) acorns dominate the mallard diet during years of good mast production and favorable water conditions in southeastern Missouri.

The bottomland hardwood swamps of the MAV are famous for their winter populations of mallards and provide 26 to 30 percent (approximately 2.8 million birds) of the entire North American mallard population. Mallards, in turn, are the most populous species of North American duck, comprising some 25 percent of the total population of the 10 principal duck species (Nichols et al. 1983). Although limited reliable data exist to indicate directly whether mallards prefer the wetter or drier portions of these forested wetlands, there is reason to believe that mallards prefer the drier areas toward the edge when water is plentiful. The edges of inundated areas provide the greatest availability of foods, such as seeds, and a wide variety of invertebrates. The optimum water depth for mallards has also been shown to be 10 to 18 inches; areas in excess of 24 inches are too deep for effective feeding. The greater percentage of the forest flooded during winter, the greater the mallard use of bottomland hardwoods (Heitmeyer 1985).

Mallards concentrate on recently flooded openings with shallow depths in bottomland forests in the early fall. Shortly after arrival, mallards complete prealternate (breeding plumage) molt and consume aquatic insects and moist soil seeds. Following molt, mallards begin courtship and by early January 90 percent of the birds are paired (Bellrose 1980). During pairing mallards forage intensively in flooded forests or agricultural fields where they consume acorns, agricultural grains, and seeds and tubers of moist soil plants. After pairing, mallards readily use shallowly flooded forests and continue to consume acorns, but increase consumption of macroinvertebrates such as isopods, snails, and fingernail clams (Table 5, Fredrickson and Batema 1992).

Table 5. Types, relative abundance, and relative biomass of foods associated with lowland hardwood habitats.[1]

	Cypress/tupelo	Oak dominated live forests	Dead tree	Scrub/shrub	Slough/ open water	Moist-soil
Plant foods						
Acorns		+++[a]				
Samaras		+++				
Buttonbush			+	++	+	
Watershield			+	+	+++	
Millet						+++
Sticktights			+	+		+++
Animal Foods						
Freshwater worms	+	+++	+	+	+	+
Sowbugs	+	+++	+	+		+
Sideswimmers	+	+++	+	+		+
Bugs	+	+	+	+	+	+++
Beetles	+	+	+	+	+	+++
Flies	+	+	+	+	+	+++
Pond snails	+		+	+	+	+++
Orb snails	+	+	+	+	+	+++
Fingernail clams	+					

[a] **Relative abundance: +++ large number and biomass,**
++ moderate number and biomass, + small number and biomass.
[1] **Fredrickson and Batema 1992.**

The MAV also provides breeding and wintering habitat for a large wood duck (*Aix sponsa*) population, which although difficult to census, may easily exceed one million birds in winter (Bellrose and Holm 1994). Wood ducks feed primarily on a variety of natural materials including hard mast (acorns of pin oak, water oak, Nuttall oak, and willow oak), invertebrates, weed seeds, aquatic tubers, and other fruits. Stream overflow is an important adjunct to food productivity. Small streams overflow frequently and briefly, sweeping organic matter and nutrients into the channel. Large streams do so less frequently, but their overflows cover the flood plain longer, often permitting woodies to take advantage of newly but temporarily created overflow habitat.

Such habitat reaches maximum expansion on the alluvial plain of the Mississippi River. The value of the vast areas overflowed by streams on the MAV during late winter and early spring is manifest in its food base for wood ducks. When and where possible, wood ducks exploit this bonanza as they prepare for the energy demands of breeding (Heitmeyer and Fredickson 1990).

Wright (1961) and Delnicki and Reinecke (1986) demonstrated the importance to waterfowl of large areas of flooded rice and soybean fields. Seeds and tubers of grasses, sedges, and other moist soil plants are also important components of the diet (Wright 1961, Wills 1970, Heitmeyer 1985, Delnicki and Reinecke 1986, Combs 1987). Invertebrates generally provide less than 10 percent of the diet in agricultural (Delnicki and Reinecke 1986) and moist soil (McKenzie 1987) habitats, but may be more important in forested wetlands (Heitmeyer 1985).

The nutrition of wintering waterfowl is not well understood. It is, however, increasingly clear that nutrition affects dietary energy and protein intake, and that meeting these dietary requirements is positively related to winters with normal or above normal rainfall. Studies conducted in Mississippi during the wet winter of 1982-83 show increased mallard body weights while the dry winter of 1980-1981 show decreased mallard body weights (Delnicke and Reinecke 1986). Similar results in Missouri indicated that mallard body weights increased when water conditions and mast production were favorable, or when rainfall was sufficient to flood low lying cropland (Heitmeyer 1985, Combs 1987). The condition of waterfowl returning to the breeding grounds has been shown to have a major impact on their breeding success and survival (Bellrose 1980, Reinecke et al. 1989).

Social Behavior

Courtship and pair formation dominate the social behavior of dabbling ducks during winter. Heitmeyer (1985) showed that progress of pair formation is related to habitat conditions and that females paired earliest when food availability and body weights were greatest. Most of the project area that is riverside of the mainline levee is forested and is widely used by waterfowl for resting or roosting areas. These forested wetlands also provide isolation from human disturbance, protection from predators, and a location for courtship and other social activities. Whereas much of the foraging and nutritional requirements can be met by flooded agricultural lands, a variety or complex of habitats is needed to satisfy the total biological requirements of wintering waterfowl, because members of the population may differ in their habitat needs at any particular time (Reinecke et al. 1989). Examples include juvenile or unpaired mallards feeding

in agricultural fields and adults and pairs seeking the isolation of shrub swamps to avoid harassment from courting parties (Heitmeyer 1985).

PROJECT IMPACTS

Project existing conditions are synonymous with the future without project conditions as they pertain to potential foraging habitat for wintering waterfowl. This determination assumes that existing institutional requirements with regard to regulating development in wetlands are sufficient to ensure continuation of existing conditions.

Project impacts consist of direct losses of flooded agricultural lands, herbaceous areas, and pastures. The levee enlargement project will not reduce flooding of waterfowl foraging areas. Direct losses of bottomland hardwood areas are not included as lost duck foraging habitat, since the wooded areas that would be used for borrow pits and levee construction do not contain 30 percent or more red oak species (*Quercus* sp.). The bottomland forests that would be affected by the project and were sampled during the Habitat Evaluation Procedures (HEP) field work, revealed tree species including box elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis occidentalis*), and elm (*Ulmus* sp), with less than five percent oaks. Waterfowl food values, as used in the following assessment methodology, are not assigned to flooded forests with less than 30 percent oak species.

IMPACT ASSESSMENT METHODOLOGY

In this section, the term wintering waterfowl includes primarily puddle ducks consisting of the mallard, northern pintail, American wigeon (*Anas americana*), gadwall (*Anas strepera*), green-winged teal (*Anas crecca*), northern shoveler (*Anas clypeata*), and blue-winged teal (*Anas discors*).

Prior waterfowl appendices incorporated a methodology that used available food (energy) as an index of the carrying capacity of winter foraging habitat for dabbling ducks in the MAV. This methodology was developed in 1992 by Mr. Robert Barkley (U.S. Fish and Wildlife Service, Vicksburg Field Office) and Dr. Kenneth J. Reinecke (Biological Research Division, Mississippi Valley Research Field Station). This method was used on several Corps flood control projects to quantify the impact of altering hydrology on traditional waterfowl wintering forage areas and for designing appropriate mitigation measures (U.S. Army Corps of Engineers 1991, 1993). This method has also been used in setting habitat management goals for wintering waterfowl habitat in the MAV (Loesch et al. 1994).

The Corps prepared a GIS data base tailored to identify the acres of available foraging habitat under existing conditions, and future conditions with and without the project. To determine carrying capacity in terms of numbers of duck-days, data requirements include land use, hydrology, and available food during the 120 day (November 1 to February 28) waterfowl wintering period. The data were specific to those habitats flooded to a depth less than 24 inches,

The amount of food available on a unit area was determined by Reinecke et al. (1989) and McAbee (1994). Small grain crop residues, moist soil native weed seeds, invertebrates, and acorns in forest stands with more than 30 percent red oaks represent the available winter waterfowl food.

For this waterfowl appendix the previously described methodology was refined to include information on seed deterioration rates and seed abundance, invertebrate abundance, as well as depth and duration of flooding (Nelms and Twedt 1996). Waterfowl foraging habitat, regardless of food value, is only of use to wintering waterfowl if available. Waterfowl use relatively shallow water areas, eighteen inches deep or less, for feeding. Through the use of extensive hydrological data, the Corps provided seasonal acres flooded twenty four inches or less for the wintering season for this analysis(Table 6). The land use data provided for the study area were specific to those acres inundated and represent only potential available foraging habitat. By including these factors, the present methodology is more representative of winter waterfowl foraging habitat.

The index of carrying capacity for wintering waterfowl foraging habitat is now expressed in duck-use-days (DUD) per acre which represents the capacity of the available forage to meet the energy requirements of one duck for one day per acre. The information requirements to estimate DUD are: (1) current land use, including crop type, (2) extent, duration, and depth of flooding, (3) amount of winter food present by land use, (4) Energy of food items, (5) deterioration rates of food items, (6) energy requirements of waterfowl, and (7) estimated density of waterfowl. The equation for this is as follows:

$$\textbf{DUD/Acre} = \frac{\textbf{Food X Energy}}{\textbf{Duck Energy Needs}}$$

The equation used to estimate DUD was further refined by factoring in the amount of seed deterioration which has a significant impact on DUD. Deterioration rates were estimated from experimental data using the best fitting regression model (Nelms and Twedt 1996). Daily seed consumption estimates were also incorporated into the equation to preclude overestimating the influence of seed deterioration because foods consumed by ducks are not subject to deterioration.

Since DUD are a function of the weight of the food available and food is easily converted to calories, calculations are in terms of the weight of food. The equation for food available to ducks on a given day when seed consumption and deterioration are taken into account is:

$$Food_j = Food_0 - \sum_{i=0}^{j} (Food_{consumed_i} - Food_{deteriorated_i})$$

where i and j are days.

By converting to DUD, units are comparable across habitats, which facilitates both wetland mitigation efforts and management decisions. This is particularly useful when the loss of one habitat must be mitigated with another habitat due to practical constraints or the need to meet multiple ecosystem management goals. DUD provide an objective index of the relative value of

Table 6.	Acres Flooded (24 in or less) Riverside and Landside Flooded During a One Year Frequency Flood		
LANDUSE	**VICKSBURG DISTRICT**	**MEMPHIS DISTRICT**	**TOTAL ACRES**
COTTON	3380	7093	10473
SOYBEANS	9658	26940	36598
CORN	2415	6286	8701
RICE	999	1151	2150
TOTAL CROPLAND	16452	41,470	57,922
PASTURE	1280	1943	3223
HERBACEOUS	3252	2202	5454
TOTAL MOIST SOIL	4532	4145	8677
BLH	46226	40490	86716
SWAMP	1112	2474	3586
TOTAL FORESTED	47338	42964	90,302
RIVER	611	1741	2352
LAKE	777	592	1369
PONDS	523	10	533
SANDBAR	405	254	659

*Note: Percent flooded computed from flood scenes representative of approximate two foot depth inundation of upper batture lands. Percentages applied to total batture lands flooded during a one year frequency event (Corps of Engineers Pers. Comm., Dave Johnson 1997).

different habitats for dabbling ducks as winter habitats.

To facilitate calculations, food item densities, deterioration rates, and energy values were aggregated within a given habitat type. Weighted averages based on weights of food items were used to calculate the aggregate values. Aggregate values are representative of any generic unit of food in the habitat of interest (Table 7).

Once aggregate values were calculated, the density of ducks feeding in the habitat of interest is projected so that daily consumption can be estimated. An overall average of systematic observations of waterfowl in flooded moist soil, rice, corn, and soybean fields in the MAV was used to estimate duck density. The estimated diurnal density of ducks in flooded rice, soybean, corn, and moist soil fields in the MAV from data collected by McAbee (1994) and Dr. Dan Twedt (Biological Research Division) and Mr. Curtis Nelms (U.S. Fish and Wildlife Service, Vicksburg) (unpublished data) is 10.1 ducks/ha. No empirical estimates of waterfowl density in flooded bottomland hardwoods (BLH) in the MAV are known to exist, so estimates from croplands and moist soil are used for BLH also. Little information is available on nocturnal feeding densities of waterfowl, although this has been shown to be an important phenomenon (Paulus 1980, Reinecke unpublished data). To adjust for nocturnal foraging, the estimate of diurnal density is doubled to 20.2 ducks/ha. The role of the projected density and subsequent consumption estimates is to dampen the effects of seed deterioration on food availability. If the average daily consumption estimates were not included in the model, then the influence of seed deterioration would be overestimated because foods consumed by ducks are no longer subject to deterioration. From these calculations, DUD/ha and Days to Exhaustion (DTE) were generated (Tables 8 and 9).

Reasonable estimates were generated for the number of days of flooding until exhaustion of food resources at an average duck density. This density is assumed to be the point where declining foraging efficiency causes ducks to abandon a field. Reinecke et al. (1989) found this threshold foraging efficiency to be 50 kg/ha. The estimated DTE of food resources is useful for determining the impact of the length of flooding on habitat values. DTE allows the inclusion of data on flood duration and is useful in determining the impacts of flood control projects on wintering waterfowl foraging habitat.

CONSTRUCTION IMPACTS

Specific to wintering waterfowl, construction impacts are those impacts consisting exclusively of construction and maintenance rights-of-way, borrow pits, and berm construction. These impacts are "direct" in that an acre-for-acre change in land use occurs (Tables 10, 11, and 12). Enlargement of the Mississippi River levees will not reduce flooding of winter waterfowl habitat but will result in direct losses of winter habitat. Plan 3, the traditional levee construction approach, would result in the direct annual loss of 233,059 DUD in the Memphis District and 365,581 in the Vicksburg District. Plan 4, the avoid and minimize alternative, would result in the annual loss of 147,332 DUD in Memphis District and 387,881DUD in the Vicksburg District (Tables 13 and 14).

TABLE 7. FOOD DENSITIES AND METABOLIZABLE ENERGY CONTENT OF FOODS IN THE MISSISSIPPI ALLUVIAL VALLEY

	Food density in kg/ha (metabolizable energy content in Kcal/kg) /1			
Foraging Habitat	Acorns	Grain	Weeds	Invertebrate
Moist Soil/Fallow Field			450 (2500)	0.69 /2 (2500
Harvested Cropland				
Corn		250 (3670)		
Rice		166 / 1&2 (2933)	32 / 1&2 (2500)	3.96 / 2 (2500
Soybean		86 / 1&2 (1871)	54 / 2 (2500)	0.44 / 2 (2500
Bottomland Hardwoods				
30% red oaks	27 (3500)		22.5 (2500)	13.7 (2500)
50% red oaks	44 (3500)		22.5 (2500)	13.7 (2500)
70% red oaks	62 (3500)		22.5 (2500)	13.7 (2500)
90% red oaks	80 (3500)		22.5 (2500)	13.7 (2500)

/1 All information from Reinecke et al. (1989) unless indicated.

/2 McAbee (1994)

TABLE 8. DUCK-USE-DAYS (PER HERCTARE AND ACRE) AND DAYS TO EXHAUSTION OF FOOD RESOURCES IN WINTER FOR FLOODED MOIST SOIL, RICE, SOYBEAN, AND BOTTOMLAND HARDWOOD FOREST. /[1]

Habitat	Duck-use-days/hectare	Duck-use-days/acre	Days to Exhaustion
Mosit Soil	2,563	1,037	126
Corn	2,397	970	118
Rice	1,434	580	71
Soybean	626	253	31
Bottomland Hardwoods 30% red oaks /[2]	222	90	11
50% red oaks	384	155	19
70% red oaks /[3]	566	229	28
90% red oaks	747	302	37

/[1] Nelms and Twedt 1996

/[2] 30% red oaks is used as the average composition in natural stand.

/[3] 70% red oaks is used in this waterfowl appendix as the average seedling survival rate in a managed stand. 229 DUD /ac are used to determine acres required to mitigate for impacts.

TABLE 9. DUCK-USE-DAYS AND DAYS TO EXHAUSTION FOR THE MISSISSIPPI MAINLINE LEVEE PROJECT, MEMPHIS, EXISTING CONDITIONS.

Habitat	DUD/acre	DTE	Percent Land Use	Weighted average DUD/acre	Weighted average DTE
Soybean	253	31	0.70	176.85	21.67
Rice	580	71	0.03	17.40	2.13
Fallow Field	1037	126	0.11	112.00	13.61
Corn	970	118	0.16	158.11	19.23
				464.35	**56.64**

VICKSBURG, EXISTING CONDITIONS.

Habitat	DUD/acre	DTE	Percent Land Use	Weighted average DUD/acre	Weighted average DTE
Soybean	253	31	0.55	138.90	17.02
Rice	580	71	0.06	33.06	4.05
Fallow Field	1037	126	0.26	266.51	32.38
Corn	970	118	0.14	132.89	16.17
				571.36	**69.61**

TABLE 10. FORAGING HABITAT AVAILABLE TO WATERFOWL, EXISTING CONDITIONS.

Land Use	MEMPHIS Acres	MEMPHIS Percent	VICKSBURG Acres	VICKSBURG Percent
Rice	1,151	3.00	999	5.70
Corn	6,286	16.30	2,415	13.70
Soybean	26,940	69.90	9,658	54.90
Fallow Field	4,145	10.80	4,532	25.70
Total	38,522	100.00	17,604	100.00

TABLE 11. PROJECT IMPACTS ON ACRES OF AVAILABLE WATERFOWL FORAGING HABITAT, PLAN 3.

Land Use	MEMPHIS Acres lost	VICKSBURG Acres lost
Rice	38	17.6
Corn	7	9.3
Soybean	217	332.8
Fallow Field	144	252.8
Total	406	612.5

TABLE 12. PROJECT IMPACTS ON ACRES OF AVAILABLE WATERFOWL FORAGING HABITAT, PLAN 4.

Land Use	MEMPHIS Acres lost	VICKSBURG Acres lost
Rice	12	31.4
Corn	18	16.7
Soybean	203	587.6
Fallow Field	69	197.5
Total	302	833.2

TABLE 13. DUCK-USE-DAYS OF AVAILABLE WATERFOWL FOOD FOR FOR EXISTING CONDITIONS.

EXISTING CONDITIONS BY REACH	ACRES OF WATERFOWL FOOD	AVERAGE DUD PER ACRE	TOTAL DUD/ACRE PER YEAR	TOTAL DUD 100 YEAR PROJECT LIFE
MEMPHIS	38,522	464.35	17,887,601	1,788,760,100
VICKSBURG	17,604	571.36	10,058,221	1,005,822,100

TABLE 14. DUD LOST DUE TO PLAN 3 AND PLAN 4.

PLAN 3	ACRES IMPACTED	DUD PER ACRE	TOTAL DUD LOST PER YEAR	TOTAL DUD LOST 100 YEAR PROJECT LIFE
MEMPHIS				
Rice	38	580	22,040	2,204,000
Corn	7	970	6,790	679,000
Soybean	217	253	54,901	5,490,100
Fallow Field	144	1,037	149,328	14,932,800
Total	406		233,059	23,305,900
VICKSBURG				
Rice	17.6	580	10,208	1,020,800
Corn	9.3	970	9,021	902,100
Soybean	332.8	253	84,198	8,419,800
Fallow Field	252.8	1,037	262,154	26,215,400
Total	612.5		365,581	36,558,100
PLAN 4				
MEMPHIS				
Rice	12	580	6,960	696,000
Corn	18	970	17,460	1,746,000
Soybean	203	253	51,359	5,135,900
Fallow Field	69	1,037	71,553	7,155,300
Total	302		147,332	14,733,200
VICKSBURG				
Rice	31.4	580	18,212	1,821,200
Corn	16.7	970	16,199	1,619,900
Soybean	587.6	253	148,663	14,866,300
Fallow Field	197.5	1,037	204,808	20,480,800
Total	833.2		387,881	38,788,100

The average annual DUD lost over the 100 year project life were reduced to reflect the 15 year construction period in the Memphis District and the 23 year construction span in the Vicksburg District (Table 15). The small amount of levee raising in the New Orleans District will not affect duck foraging habitat. Environmentally designed pits including the shallow fringes around constructed islands and the shallow areas with 10:1 slopes, will provide some value as waterfowl foraging areas.

CONCEPTUAL MITIGATION MEASURES

As just stated, completion of the Mississippi River Mainline Levees project would result in losses of wintering migratory waterfowl habitat. The following discussion, which is conceptual, is intended to provide examples of how intensively managing wintering waterfowl on existing public lands can both increase foraging habitat for wintering waterfowl and meet their broader ecological requirements.

Reforestation

Reforestation is the Service's preferred mitigation technique for several reasons. 1) Reforestation constitutes an ecosystem approach to replacing the waterfowl values that would be lost through project construction. Instead of concentrating on implementing a mitigation feature aimed at primarily replacing the lost food values, reforestation would address all of the waterfowl habitat needs. In this appendix we have used food as an index of waterfowl habitat needs. Waterfowl are not able to divide their world and habitat needs into such neat compartments. A bottomland hardwood forest ecosystem provides food and the other waterfowl habitat needs such as courtship sites, protection from predators and adverse weather, resting and roosting areas, and isolation from human disturbance. 2) Reforestation would provide a stable, low maintenance, high reliability mitigation feature. These mitigation features are supposed to last for the 50 year project life. Other mitigation techniques that would replace lost waterfowl food values, such as moist soil management areas, would require frequent maintenance and active operation in order to provide the predicted food supply. With constantly changing funding priorities a "no maintenance-no operation-self sustaining" mitigation feature is much more reliable and cheaper. 3) The chance of successful waterfowl habitat value replacement is highest with reforestation. Reforestation would create a system that would mimic the previously existing bottomland hardwood ecosystem, which had a long term proven record of providing high quality waterfowl habitat (Reinecke et al. 1989). 4) Application of the principles of landscape ecology dictate that we use reforestation as the primary mitigation technique. In order to establish landscape diversity, large blocks of forested habitat should be kept intact and fragmented blocks of forest should be connected by establishment of forested corridors. While meeting the needs of waterfowl, bottomland hardwood forests would also meet the needs of neotropical migratory birds many of which are declining (Hunter et al. 1993, Mueller et al. In press). Other management techniques would not benefit neotropical migratory birds. 5) Reforestation would also offset terrestrial and wetland losses. 6) Reforestation of marginal agricultural or other cleared lands is easily accomplished, as compared to the intensive management involved in

TABLE 15. ADJUSTED AVERAGE ANNUAL DUD LOST AND DUD LOST OVER THE PROJECT LIFE,

MEMPHIS DISTRICT.

PLAN	AVERAGE ANNUAL DUD *	TOTAL DUD LOST OVER THE 100 YEAR PROJECT LIFE
3	215,580	21,558,000
4	136,282	13,628,200

VICKSBURG DISTIRCT.

PLAN	AVERAGE ANNUAL DUD **	TOTAL DUD LOST OVER THE 100 YEAR PROJECT LIFE
3	323,539	32,353,900
4	343,275	34,327,500

* Memphis construction period = 15 years
(233,059 DUD X 100 years - 233,059 DUD X 15 years / 2) /100 years = 215,580 AADUD

*(147,332 DUD X 100 years - 147,332 DUD X 15 years / 2) /100 years = 136,282 AADUD

** Vicksburg construction period = 23 years
(365,581 DUD X 100 years - 365,581 DUD X 23 years / 2) / 100 years = 323,539 AADUD

**(387,881 DUD X 100 years - 387,581 DUD X 23 years / 2) /100 years = 343,275 AADUD

establishing and maintaining a moist soil area. Actions required for reforestation include direct seeding or planting seedlings and other activities ranging from extensive mowing and fertilization to only seed bed preparation.

Reforestated compensation areas should be on drained areas that were subject to frequent and sustained winter flooding 18 inches or less, but no longer provide winter grazing habitat for waterfowl. Measures such as filling and plugging ditches to restore the altered flooding regime should be implemented to ensure annual flooding of the mitigation site during the winter waterfowl period. Forest stand composition should intentionally favor heavy seeded species dominated by red oaks for maximum benefits to wintering waterfowl. Tables 16 and 17 show the potential mitigation acres that would be required based on DUD lost as a result of direct impacts to foraging habitat from borrow areas and levee enlargements. For example, the Service recommends reforestation with 70 percent red oaks with a value of 229 DUD/ac per year. However, the oaks on the reforestation site will not produce mast for approximately 20 years. Therefore, the value for ducks over the 100 year project life of 70 per cent red oak reforestation is 229 DUD/ac/year x 80 years = 18,320 DUD. In addition, during the first five years of the reforestation site establishment, weeds and grasses will be growing with the new tree seedlings. This initial five year period is given moist soil value (1,037 DUD/ac/year x 5= 5,185 DUD). After the first five years at the reforestation site no credit is given for waterfowl foraging as the area becomes a dense thicket of no value to waterfowl until the oaks produce mast at year 20. Thus, the 70 percent oak reforestation site provides 23,505 DUD (18,320 oaks + 5,185 moist soil) over the 100 year project life.

Plan 4 would result in the loss of 13,628,200 DUD over the life of the project (100 x 136,282 DUD lost annually) in the Memphis District and would require 580 mitigation acres (13,628,200 DUD div. by 23,505 DUD provided by the oak reforestation at 70 percent). The loss of 34,327,500 DUD (100 x 343,275 DUD lost annually) in the Vicksburg District would require 1,460 acres (34,327,500 DUD div. by 23,505 DUD provided by oak reforestation at 70 percent). Through the use of water control structures moist soil, rice, corn, and soybean fields could be used to offset impacts resulting from project construction. However, intensive management is required to achieve desired results with these methods.

In addition to food values, other benefits to wintering waterfowl would also be realized from the establishment or enhancement of forested wetlands. Benefits would include resting, isolation for pair bonding, better protection from disturbance and harassment than in more open areas, and protection from predation and extremes in weather conditions.

Unquantified benefits resulting from establishment of more dependable, forested wintering waterfowl foraging habitat accrue to the whole range of resident and migratory species attracted to wetlands as well as overall wetland functional values. Not intended as all inclusive, the list of fauna benefitting would include resident aquatic furbearers, resident and migrant shore and water birds, insectivorous and seed eating nontropical birds, native amphibians and reptiles, and the broad range of resident game and nongame birds and mammals known to spend time in forested wetlands and non-wooded wetlands such as moist soil areas.

TABLE 16. POTENTIAL MITIGATION REQUIRED, PLAN 3.

LAND USE	DUD 100 YEAR PROJECT LIFE	MEMPHIS MITIGATION FOR 21,558,000 DUD LOST	VICKSBURG MITIGATION FOR 32,353,900 DUD LOST
		acres	*acres*
MOIST SOIL	103,700	208	312
CORN	97,000	222	336
RICE	58,000	372	558
SOYBEAN	25,300	852	1,279
BLH			
@ 30% RED OAKS	12,385*	1,741	2,612
@ 50% RED OAKS	17,585*	1,226	1,840
@ 70% RED OAKS	23,505*	917	1,376
@ 90% RED OAKS	29,345*	735	1,103

* Includes 5,185 DUD from moist soil habitat for the first five years after seedlings are plante All DUD/ac values assume the mitigation site will be flooded <18 inches or less during the waterfowl season.

TABLE 17. POTENTIAL MITIGATION REQUIRED, PLAN 4.

LAND USE	DUD 100 YEAR PROJECT LIFE	MEMPHIS MITIGATION FOR 13,628,200 DUD LOST	VICKSBURG MITIGATION FOR 34,327,500 DUD LOST
		acres	*acres*
MOIST SOIL	103,700	131	331
CORN	97,000	140	354
RICE	58,000	235	592
SOYBEAN	25,300	539	1,357
BLH			
@ 30% RED OAKS	12,385*	1,100	2,772
@ 50% RED OAKS	17,585*	775	1,952
@ 70% RED OAKS	23,505*	580	1,460
@ 90% RED OAKS	29,345*	464	1,170

* Includes 5,185 DUD from moist soil habitat for the first five years after seedlings are plante All DUD/ac values assume the mitigation site will be flooded <18 inches or less during the waterfowl season.

Other functional wetland values would include flood storage, water quality attributes, ground water recharge, esthetics, and scientific study opportunities. Additionally, economic benefits would result from added outdoor recreation opportunities and the harvest of timber and other wood products. Economic losses could result in those instances where existing agricultural practices/leases might have to be modified.

Borrow Areas

As previously discussed, environmentally designed borrow pits will have considerable shallow areas around artificial islands and in areas with 10:1 slopes. The Corps has calculated that seven percent of the 3,221 acres of borrow pits (225 acres) constructed in open, agricultural areas would provide duck foraging habitat. The Service concurs with this assumption. Fringe areas of borrow pits located in forested areas would not produce invertebrates, tubers, and seeds of value to waterfowl and were not included as foraging areas. A value of 645 DUD/acre were given for shallow areas of agricultural borrow pits (the average of the lowest and highest DUD/acre-soybeans and moist soil). Table 18 reveals the mitigation acres required in the Vicksburg District after deducting the DUD benefits of fringe habitat in open area borrow pits (849 acres for oak reforestation at 70 percent). All but two acres of the beneficial borrow areas would be created in the Vicksburg District, therefore all benefits were assigned to that District.

CONCLUSION

Implementation of the proposed levee enlargement project would result in adverse impacts to migratory waterfowl wintering habitat. Losses would occur on both the river side and land side of the Mainline Levee. Within both the Memphis and Vicksburg Districts, implementation of the traditional levee construction approach, Plan 3, would reduce wintering waterfowl foraging habitat carrying capacity annually by approximately 598,640 DUD, and Plan 4, the avoid and minimize alternative, would reduce annual carry capacity by approximately 535,213 DUD. Compensation by reforestation with 70 percent oaks would require 2,293 acres for Plan 3 and 1,429 acres for Plan 4, the avoid and minimize plan. The Service recommends the implementation of Plan 4.

The losses described above are of concern to the Service not only because of the adverse impacts upon migratory waterfowl, a federal trust species, but also because of the adverse impacts to the study area ecosystem.

TABLE 18. VICKSBURG MITIGATION ACRES REQUIRED for PLAN 4 CONSIDERING DUD BENEFITS, FROM BORROW PITS.

LAND USE	DUD 100 YEAR PROJECT LIFE	MITIGATION FOR 19,944,000 **DUD LOST
		acres
MOIST SOIL	103,700	192
CORN	97,000	206
RICE	58,000	344
SOYBEAN	25,300	788
BLH @ 30% RED OAKS	*12,385	1,610
@ 50% RED OAKS	*17,585	1,134
@ 70% RED OAKS	*23,505	849
@ 90% RED OAKS	*29,345	680

* Includes 5,185 DUD from moist soil habitat for the first five years after BLH seedlings are planted.

All DUD/ac values assume the mitigation site will be flooded <18 inches or less during the waterfowl season.

**225 acres of fringe waterfowl food habitat created through borrow pit construction.
Fringe borrow pit habitat = 645 DUD/ac. 225 ac X 645 DUD/ac = 143,835 DUD benefits.
143,835 DUD x 100 years = 14,383,500 DUD benefits over the 100 year project life.
34,327,500 lost - 14,383,500 DUD benefits = 19,944,000 DUD lost.

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APPENDIX 10
TERRESTRIAL ANALYSIS

PREFACE

The U.S. Army Corps Of Engineers has been authorized to provide project flood protection to the lower Mississippi River Valley. This report contains an analysis of impacts of the levees portion of the Mississippi River and Tributaries Project on terrestrial resources in the Memphis, Vicksburg, and New Orleans Districts. This levee work accomplishes the authorized flood damage reduction in the Valley. While five alternative plans were considered for this project, this report includes an analysis of the two structural plans. These plans include completion of the traditional plan that represents the traditional method for levee construction, with borrow material taken from the closest engineeringly feasible area, which is normally riverside of the work site; and a plan that uses reasonable environmental design measures to avoid and minimize adverse impacts to significant environmental resources riverside of the mainline levees. These plans are designated Plan 3 and Plan 4, respectively.

This analysis involved the use of the U.S. Fish and Wildlife Service Habitat Evaluation Procedures and was accomplished in cooperation with three terrestrial Habitat Evaluation Procedures teams. These teams were composed of professional biologists from the Corps of Engineers; U.S. Fish and Wildlife Service; Arkansas Game and Fish Commission; Louisiana Department of Wildlife and Fisheries; the Mississippi Department of Wildlife, Fisheries and Parks; and Kentucky Department of Fish and Wildlife Resources.

ABSTRACT

The U.S. Fish and Wildlife Service Habitat Evaluation Procedures were used to quantify impacts of the project to terrestrial wildlife habitats in the Lower Mississippi River alluvial valley. Six evaluation species--barred owl, fox squirrel, Carolina chickadee, pileated woodpecker, wood duck, and mink--were chosen to represent the habitat requirements of wildlife inhabiting the bottom-land hardwood forests in the project area. The quality of habitat for each species was determined by measuring specific habitat variables (e.g., canopy cover, tree height, size and abundance of snags) on sample plots and entering these data into Habitat Suitability Index (HSI) models for each species.

Impacts were estimated for each of the two structural plans studied in detail--Plan 3 (the traditional plan) and Plan 4 (the plan using environmental design measures to avoid and minimize impacts). Baseline (preproject) HSI values ranged from .28 to .84 for barred owls, Carolina chickadee, pileated woodpeckers, wood ducks, and mink (in riverine and lacustrine habitats). HSI's were 0 for mink in forested wetlands due to the lack of long-duration flooding in the forest.

Impacts of each plan were determined by calculating the net change in average annual habitat units (AAHU's) between without-project and with-project plans for each evaluation species. Impacts of Plan 3 were estimated at 19,565 AAHU's for all species combined and Plan 4 at 6,861 AAHU's.

Complete compensation for project-induced habitat losses would require between 2,000 and 3,530 acres of reforestation, depending upon the time of reforestation, the proximity and permanence of water at the reforestation site, and the method of reforestation.

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
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APPENDIX 10
TERRESTRIAL ANALYSIS

BACKGROUND AND OBJECTIVES

1. Following the tremendous flood of 1927, Congress passed the Flood Control Act of 1928 committing the Federal Government to a comprehensive program of flood control and authorizing the Mississippi River and Tributaries Project (MR&T). The MR&T project is designed to control a "project flood" with a discharge of 3 million cubic feet per second in the alluvial valley of the lower Mississippi River (U.S. Army Corps of Engineers, 1987).

2. A major flood occurred on the lower Mississippi River from early March 1973 until mid-June 1973. Although still incomplete, the MR&T project for flood control on the lower Mississippi River overall performed splendidly during this flood. However, as the flood developed and stage-discharge relation data were collected and analyzed, it became apparent that the channel capacity of both the lower Mississippi River and the lower portion of the Atchafalaya Basin Floodway had seriously deteriorated. A new design flood flow line was established, and it demonstrated the need to raise many miles of levees to provide protection against the project design flood (U.S. Army Corps of Engineers, 1973). The needed levee enlargement was realized in 1973 and could be completed by 2020. This appendix will evaluate the effects of two alternative plans to enlarge the levees and measures to control seepage under the levees and related works in the Memphis, Vicksburg, and New Orleans Districts. This work to provide flood protection is commonly referred to as the Mississippi River Levees (MRL) Project.

3. The objectives of the work presented in this appendix were (a) to determine baseline (pre-project) habitat suitability for selected wildlife species in the MRL project area, (b) estimate potential impacts for each species comparing the "without-project" conditions and the alternative "with-project" conditions, and (c) estimate the need for any compensation measures.

4. Only direct impacts of project construction were evaluated since there will not be any project-induced changes in flooding frequency or duration in the project area. Only impacts to bottomland hardwoods were evaluated since these woodlands are the only significant terrestrial resource in the project area.

ALTERNATIVES

NO-ACTION ALTERNATIVE

5. No new construction; i.e., seepage control, frontal protection, and levee height increases, only normal maintenance, repair, and replacement would be done. Thus, existing levees, berms, and floodways would remain in place as the only flood protection. Therefore, the threat of catastrophic flooding would continue. Local levee boards and the Corps would continue to expend funds in flood-fight efforts, including temporarily raising levee reaches and sandbagging sand boils.

6. As part of a report prepared in FY 97 at the direction of the U.S. Senate, limited studies were conducted to determine the expected damages from crevasses in the Mississippi River mainline levees at Mayersville, Mississippi, and Lake Providence, Louisiana. These investigations provide an indication of how catastrophic the impacts from a levee failure would be to the rest of the study area.

7. Crevasses near the small towns of Mayersville and Lake Providence, located in the central Delta region, would cause catastrophic flooding over approximately 25,000 square miles, directly affecting approximately 114,000 people, 40,000 residences, and 1,600 businesses in 12 counties and parishes along the river. Plate 47 (Appendix 4) shows the flood plain area that would be inundated with a levee failure at Lake Providence, Louisiana, and Plate 48 (Appendix 4) illustrates the alluvial area that would be inundated with a levee crevasse at Mayersville, Mississippi. Results of damage analyses indicate levee crevasses could potentially cause direct flood damages approaching $5.0 billion--almost $2.0 billion in the areas along the east bank of the Mississippi River and $3.0 billion on the west bank.

8. A summary of flood damages/losses is depicted in Table 10-1.

TABLE 10-1
LEVEE CREVASSE AT MAYERSVILLE, MISSISSIPPI,
AND LAKE PROVIDENCE, LOUISIANA
SUMMARY OF FLOOD DAMAGES/LOSSES
($000)

Damage/Loss Category	Lake Providence Levee Crevasse	Mayersville Levee Crevasse	Total Damages/Losses
Structure Damages	1,139,746	426,264	1,566,010
Business Losses	1,031,039	569,989	1,601,028
Public Utilities	79,782	29,838	109,620
Road and Bridge Damages	22,809	8,365	31,174
Agricultural Losses	447,144	468,247	915,391
Noncrop Damages	60,823	37,846	98,669
Traffic Rerouting	72,162	3,604	75,766
Emergency Costs	50,403	39,840	90,243
Evacuation and Subsistence Costs	26,821	21,200	48,021
Reoccupation Costs	42,471	33,570	76,041
TOTALS	2,973,200	1,638,763	4,611,963

9. Since the no-action alternative would not provide protection from the Project Design Flood (PDF) and is unacceptable to Congress and the general public and thus unimplementable, no further consideration was given to the no-action option.

PLAN 1 - NONSTRUCTURAL ALTERNATIVE

10. Plan 1 represents a nonstructural option to structural flood damage reduction. Basically, only two types of practicable nonstructural measures for flood protection exist--those which reduce existing damages and those which reimburse for existing damages and reduce future damage potential. Those nonstructural measures which reduce damages were not applicable to levee overtopping and catastrophic levee failure. The nonstructural measure which compensates or reimburses for existing damages that was addressed was purchasing easements in lieu of providing flood protection from the PDF. Existing levee protection would be maintained as in the no-action alternative. However, should the levee be overtopped and catastrophic levee failure occur, the levee would not be reconstructed.

11. Nonstructural alternatives such as acquisition of flowage easements can be utilized only if they further a project purpose or there is some legal obligation for them. Flowage easements were considered as a substitute for provision of PDF protection through levee raising. Such an alternative would not accomplish the congressionally mandated project purpose to provide a prescribed level of flood protection. In view of this and considering the prohibitive implementation and continuing costs and certain public unacceptability, a nonstructural plan would not be implementable. It was given no additional consideration.

STRUCTURAL ALTERNATIVES

12. Three structural alternatives were addressed in the preliminary screening-- Plan 2, landside borrow; Plan 3, traditional method (riverside borrow); and Plan 4, environmental design (avoid and minimize) to construct levee enlargement and seepage control.

Plan 2 - Landside Borrow

13. This alternative presumes continuing construction of levee enlargement and raising, seepage control, and frontal protection. All borrow material would be obtained from landside of the levee. Three landside borrow schemes were investigated:

a. Plan 2A - Traditional landside borrow.

(1) Plan 2A consists of purchasing rights-of-way for traditional rectangular borrow areas 8 to 10 feet deep in a band 2,000 to 3,000 feet from the landside toe of the levee where feasible (see Plate 49, Appendix 4). A minimum distance of 2,000 feet from the landside levee toe to the closest borrow area is required to prevent underseepage problems and a maximum of 3,000 feet from the landside levee toe was used as the outer limit on the distance to haul borrow for levee and berm construction.

(2) Suitable material would be excavated and used to enlarge the levee as shown on Plate 49 (Appendix 4) or to construct berms. The landside rights-of-way would be expensive. The extended borrow haul distance would also increase costs.

(3) Water quality in the landside borrow areas would likely be poor due to runoff from adjacent agricultural fields. The runoff would carry high loads of suspended sediments, nutrients, and organochlorine pesticides. Existing landside borrow areas have high levels of DDE. Fish tissue levels of DDE from samples acquired as a part of these studies approach the FDA action levels for fish consumption and are two orders of magnitude above the no observable effects level for these pesticides.

b. Plan 2B - Traditional landside borrow with forested buffer.

(1) This alternative consists of a deep (average 8 feet) borrow area which would be protected by a forested buffer zone approximately equal in area to the borrow, with a protective berm around the outside of the buffer to prevent chemicals from entering the borrow area (see Plate 50, Appendix 4). As in Plan 2A, the required location for the borrow area is 2,000 to 3,000 feet landside of the levee toe.

(2) Plate 50 (Appendix 4) shows the excavated borrow area with the material used to enlarge the levee. The forested buffer area and protective dike are shown on the borrow area periphery. This design would isolate the borrow from the local drainage which carries pesticides, thereby improving water quality. However, this requires additional cost for engineering and design and lands and damages.

c. Plan 2C - Landside shallow borrow. Landside shallow borrow allows for draining the borrow area so that it can be forested. Borrow excavation is limited to 3 feet deep and shaped to drain and connect to local drainage, thereby providing habitat for tree growth. As in the previous landside borrow areas, the required location is in a band 2,000 to 3,000 feet from the landside toe of the levee. Plate 51 (Appendix 4) shows a typical layout of borrow area location, excavation and levee enlargement, and forested borrow. This shallow borrow greatly expands the required borrow area acreage, increasing lands and damages costs commensurately.

Plan 3 - Traditional Method

14. Plan 3 is the traditional historical method to construct levee enlargements and berms. New and innovative designs to reduce the cross-sectional area of the levees have been incorporated and, where possible, the levee enlargement is located to the side requiring the least amount of material.

15. The borrow areas are normally located riverside as close to the construction site as engineeringly feasible (proper soil for levee embankment) and excavated as deep as soil layers will allow (see Plate 52, Appendix 4). This plan requires no special configuration or location of the borrow areas other than for engineering purposes. No provisions are made for drainage or environmental enhancement of the borrow areas. However, past experience has shown that a majority of the resulting borrow areas permanently hold water which is replenished or "flushed" periodically by normal river fluctuations.

16. The traditional method analysis consisted first of printing GIS maps that contain the following data layers: base topographic features, land cover mapping, jurisdictional wetland mapping, and items of work. The items of work layer included enlargement footprints, berm footprints, and original borrow areas. To develop the layout of the plan described as Plan 3, the engineering design team located the borrow areas for the traditional method on the items of work mapping layer.

Plan 4 - Environmental Design (Avoid-and-Minimize)

17. Plan 4 is an environmental design which incorporates measures to avoid and minimize environmental damages to bottom-land hardwoods and wetlands. To develop the layout of the plan, interdisciplinary teams of state and Federal agencies representatives, local sponsors, and Corps staff were formed. They initially focused on relocating the construction borrow areas using the following placement prioritization criteria as a guide.

a. Landside cropland from willing sellers.

b. Landside cropland when riverside locations were unavailable.

c. Riverside prior-converted cropland.

d. Riverside tree plantations.

e. Riverside farmed wetlands (cropland).

f. Riverside farmed wetlands (pasture).

g. Riverside herbaceous wetlands.

h. Riverside forested nonwetland.

i. Riverside forested wetland.

j. Landside and riverside bottom-land hardwoods with black bear presence.

k. Landside cropland condemnation.

18. However, as various methods of construction were evaluated for each work item, it became apparent that the prioritization criteria could not be strictly and consistently applied to the entire MRL study area. For example, in the New Orleans District, the area between the top bank of the river and the levee is relatively narrow and often developed, whereas in the Vicksburg District, these areas are relatively wide and undeveloped. Riverside land use in the Vicksburg District is split between cropland and forested, but in the Memphis District, the riverside land use becomes predominantly cropland. Rather than apply the prioritization scheme mechanically, the study team evaluated each individual item and applied the avoid-and-minimize techniques as was most reasonable, considering the environmental, economic, and engineering solutions available for that item.

19. The teams also considered other innovative design approaches for reducing bottom-land hardwoods and wetlands effects. When environmentally, economically, and engineeringly feasible, existing berm material may be used to enlarge the levee (see Plate 53, Appendix 4) and replace the excavated berm with material dredged from the river (see Plates 54 and 55, Appendix 4). As shown on Plate 54, the only environmental loss would be temporary and comprised of a narrow path in which to lay the dredge pipe from the river to the berm site while pumping dredged material. Plate 29, Appendix 4, shows the locations of work items 498.0-L, 497.0-L, 495.0-L, and 493.0-L (these four items have been combined and renamed work item 496.0-L) and the dredge site locations in the Mississippi River to be used for borrow to construct these work items. The use of relief wells or cutoff trenches to control seepage instead of berms could be used if engineeringly and environmentally feasible. The relief wells or cutoff trenches would only temporarily affect the environment during construction.

Structural Alternatives Screening

20. The structural alternatives were screened to determine the most viable and implementable plans (see Project Report). Plans 3 and 4 were selected, carried forward into design, and evaluated in detail.

OVERVIEW OF HABITAT EVALUATION PROCEDURES

21. Habitat Evaluation Procedures (HEP) is an accounting system for quantifying and displaying habitat availability for fish and wildlife. HEP is based on Habitat Suitability Index (HSI) models that describe the habitat requirements of a species or group of species. HSI models use measurements of appropriate variables to rate the habitat on a scale of 0 (unsuitable) to 1.0 (optimal). In a typical HEP study, a number of evaluation species are chosen for each area that meets a specified standard of homogeneity (i.e., cover type) of interest in the project area. Species may be chosen because of their ecological, recreational, or economic value, or because they represent groups of species (i.e., guilds) that have similar habitat needs (Roberts and O'Neil, 1985).

22. After cover types in the project area have been mapped and evaluation species have been selected, habitat variables contained in the HSI models for each species are measured from maps, aerial photographs, and by onsite sampling. HSI values are then calculated, and the initial or baseline number of habitat units (HU's) is determined for each species. One HU is equivalent to 1 acre of optimal habitat; therefore, the number of HU's for a species is calculated as the number of acres of available habitat times its suitability (HU = HSI x acres).

23. HSI's appropriate to each species are determined for each of several target years over the economic life of the project which is 100 years. Estimates of future habitat conditions are made for the without-project alternative and for each with-project alternative. Impacts on each species are then determined by calculating the difference in average annual habitat units (AAHU's) which are the annualized products of habitat quality, acres, and time between with- and without-project alternatives. (The preceding information was adapted from Wakeley and O'Neil, 1988).

PROJECT AREA AND METHODS

24. For purposes of this study, the no-action alternative and Plans 3 and 4 of the structural alternatives were evaluated in detail.

HEP TEAM

25. The function of the "HEP team" is to guide the evaluation, monitor its progress, approve intermediate results, and make changes in direction, if needed. As stated previously, the terrestrial HEP teams for the MRL Project were composed of biologists from the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service (FWS), and the various state agencies with the responsibility of managing wildlife resources that could be affected.

PROJECT AREA

26. The MRL project area consisted of all lands and waters between the mainline Mississippi River Levees and the lands and waters within 3,000 feet landside of the landside toe of the levees in each Corps District. The project area also includes several additional levees, a floodwall, and a floodway in the Memphis District. The project areas for these related works consisted generally of the lands between various streams and levees and all lands within 3,000 feet on their landsides, or backsides. Table 10-2 contains the extent of all land uses in the project area.

TABLE 10-2
PROJECT AREA LAND USE ACREAGE

Land Use	Nonwetland	Wetland	Total
Forested	385,456	636,254	1,021,710
Cropland	537,704	231,556	769,260
Urban/Industrial	71,570	4,594	76,164
Scrub/Shrub	23,939	43,440	67,379
Tree Plantations	27,887	22,584	50,471
Sandbar	3,790	45,600 a/	49,390
Pasture	22,854	19,536	42,390
Levee	26,990		26,990
Herbaceous	3,469	11,043	14,512
Marsh		5,925	5,925
Bare Soil	1,742	1,825	3,567
Subtotal	1,105,401	1,022,357	2,127,758
Open Water			518,086
Total			2,645,844

a/ Jurisdictional (regulated) water of the United States, but may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

EVALUATION SPECIES

27. Six species were selected for evaluation of wildlife habitat impacts by the project. These species were selected by terrestrial HEP teams to represent the wildlife community that uses the bottom-land forests in the project area. The evaluation species include the barred owl (Strix varia), fox squirrel (Sciurus niger), Carolina chickadee (Parus carolinensis), pileated woodpecker (Dryocopus pileatus), wood duck (Aix sponsa), and mink (Mustela vison).

HABITAT SUITABILITY INDEX MODELS

28. Published HSI models were evaluated for five of the evaluation species -- barred owl (Allen, 1987a), fox squirrel (Allen, 1987b), pileated woodpecker (Schroeder, 1983a), wood duck (Sousa and Farmer, 1983), and mink (Allen, 1986). The wood duck model contained two parts, a breeding model and a winter model. Only the breeding model was used to reflect both losses

and gains in breeding habitat caused by project implementation. For the mink only the forested lands bordering permanent water were used in this analysis. A model for the Carolina chickadee was developed by FWS, based on an existing model for the Black-Capped Chickadee (Parus atricapillus) (Schroder, 1983b).

29. These models have been used in evaluating other projects in the Yazoo River Basin of Mississippi and have been scrutinized by other HEP teams. The models have been found adequate for determining the impacts of water resource projects on the wildlife community of bottom-land forests in the Lower Mississippi Region.

ESTIMATING HABITAT VARIABLES

Sampling Teams

30. Habitat variables contained in the HSI models were measured during May, July, and August 1996 and 1997 by sampling teams composed of biologists from the Louisiana Department of Wildlife and Fisheries; Mississippi Department of Wildlife, Fisheries and Parks; Arkansas Game and Fish Commission; Kentucky Department of Fish and Wildlife Resources; Corps of Engineers; and FWS.

Number and Location of Plots

31. Habitat variables in the various states were measured within nested 0.1- and 0.2-acre circular plots. The plots were established at intervals along the levees located at various distances from the toe of the levees on the riverside and landside. This sampling scheme was not practical in a portion of Louisiana on the riverside due to the absence of access points at equal intervals. Aquatic borrow sites in this area were more continuous which allowed only sampling at access points to wooded areas. Two circular plot samples were taken in Louisiana at each of these access points. Another exception to the systematic sampling scheme was made in the New Orleans District where only six small areas are required for levee construction. These areas were sampled directly. Also, only one plot was taken at a borrow area in the New Orleans District that would impact a total of approximately 0.4 acre of forested land. A total of 164 plots were sampled, of which 37 samples were taken landside of the levees and 127 samples were taken riverside of the levees.

Plot Sampling

32. Habitat characteristics sampled were those specified in the published HSI model for the representative evaluation species. Habitat variables were either estimated directly or calculated later from data collected in the field. Unless otherwise specified, all data were collected on a 37-foot radius (0.1-acre) plot.

33. Plots were first classified by cover type and then the tree layer was sampled. The tree layer consisted of all woody plants >20 feet tall, excluding vines. Trees rooted in the plot were classified visually as either overstory (at least 80 percent of the height of the tallest tree) or understory, and identified to species.

34. The diameter breast height (DBH) of each tree was measured to the nearest inch, and the average height of all trees was estimated visually or measured with a clinometer, or similar device. Tree counts and DBH measurements were later used to calculate the mean DBH of overstory trees, and the number of hard mast species ≥ 10 inches DBH. Oaks (Quercus) and hickories (Carya) were the only hard-mast genera in the project area.

35. To improve the accuracy and consistency of visual estimates of percent cover, each agency represented would make an independent estimate, compare estimates with another team member, and either arrive at a consensus or average. Percent cover was estimated separately for all trees, overstory trees, emergent herbaceous vegetation, potential wood duck brood cover, and shoreline cover. The last three variables were measured at inundated or shoreline plots only. In addition, the proportion of tree canopy cover that consisted of hard-mast producers ≥ 10 inches DBH was estimated.

36. The shrub layer consisted of woody plants 3 to 20 feet tall, including vines. Estimates were made of the percent cover of shrubs and of trees and shrubs combined.

37. The following data were collected within a 53-foot radius plot. The number of stumps (>1 foot tall and >7 inches in diameter), and logs (>7 inches in diameter at the large end and >3 feet long) in the plot were determined. The number of living trees with cavities >1 inch in diameter, found in the trunk or limbs >4 inches in diameter was determined. Wood duck cavities included cavities at least 3 by 4 inches found in trees or snags ≥6 feet above the ground and wood duck boxes that were maintained and predator-proof.

38. Snags were defined as standing dead trees >4 inches in diameter and ≥6 feet tall, including live trees from which >50 percent of the branches had fallen or were present but no longer producing foliage. DBH measurements of all snags in the plot were used to calculate the density of snags >4 inches DBH, density of snags >15 inches DBH, and the mean DBH of snags >15 inches DBH.

<u>Calculating Baseline Habitat Conditions</u>

39. Mean habitat variables for the entire project area were entered into the HSI models for each evaluation species. The methodology described in the models in determining the overall HSI value for the evaluation species is to use the lowest of the suitability indices for a particular habitat component. Therefore, it is quite possible that an overall HSI value can be very low or even "0" for some evaluation species. As stated previously, baseline habitat units were calculated by multiplying HSI values by existing habitat acreage in the project area.

<u>Project Life and Period of Analysis</u>

40. HEP requires that habitat availability for each evaluation species be estimated for each of several target years over a period of analysis. Construction could be completed as early as the year 2020. Since the project life is 100 years, the period of analysis (1997-2097) was used.

Calculating Average Annual Habitat Units

41. The impacts of completing construction both as it has been done in the past (Plan 3) and as it could be using environmental design and compensation measures (Plan 4) were determined by calculating the net change in AAHU's between both these two plans and the without-project condition for each evaluation species.

42. According to the mink HSI model, impacts of clearing to mink habitat in the project area are limited to areas within 328 feet from permanent water. Therefore, acreage of mink habitat was estimated by totaling the acreage of forested borders of aquatic areas within the potential impact zones in the project area. In addition, an area 75 feet wide around each aquatic borrow area was considered as wood duck habitat. Impacts to these areas were then quantified and used in evaluating project effects.

BASELINE HABITAT CONDITIONS

EXTENT OF HABITAT AND HSI VALUES

43. The amount of variability in habitat measurements was probably typical for bottom-land forests comprised of early and later successional woodlands, and also mixed woods. The total acreage of bottom-land hardwoods in the project area is 1,021,710 acres (Table 10-2). HSI values for the six evaluation species by Corps District are presented in Table 10-3. HSI values were determined for wooded areas that could be impacted by the project. The values may not be indicative of how suitable all woodlands are in the project area for the evaluation species.

TABLE 10-3
HSI VALUES FOR EXISTING CONDITIONS a/

Evaluation Species	HSI for Riverside Hardwoods	HSI for Landside Hardwoods	HSI for Riverside and Landside Plantations
Memphis District			
Barred owl	.67	.46	N/A b/
Fox squirrel	.40	.64	N/A
Carolina chickadee	.86	.84	N/A
Pileated woodpecker	.35	.21	N/A
Mink	.58	.0	N/A
Wood duck	.47	.0	N/A
Vicksburg District			
Barred owl	.54	.49	.04
Fox squirrel	.52	.38	.02
Carolina chickadee	.64	.64	.00
Pileated woodpecker	.28	.28	.00
Mink	.74	.62	.00
Wood duck	.40	.07	.00
New Orleans District			
Barred owl	.36	N/A c/	N/A b/
Fox squirrel	.13	N/A	N/A
Carolina chickadee	.48	N/A	N/A
Pileated woodpecker	.00	N/A	N/A
Mink	.67	N/A	N/A
Wood duck	.00	N/A	N/A

a/ HSI values were determined for the woodland zones that could be impacted by the project. They may not be indicative of the habitat suitability in all woodlands in the project area.
b/ No tree plantations will be affected in the Memphis District.
c/ No avoid-and-minimize measures would result in a decision to relocate borrow areas in wooded landside areas.

NET CHANGE IN ACREAGE AND AVERAGE ANNUAL HABITAT UNITS

44. Impacts of the project to bottom-land hardwoods were determined by calculating the change in acreage between the without-project alternative and each structural plan in each Corps District and then totaling them for the entire project area. The net total loss of bottom-land hardwoods (without compensation measures) for Plans 3 and 4 were 11,584 acres and 4,834 acres, respectively. In addition, Plan 3 would impact 636 acres of tree plantations and Plan 4 would impact 1,104 acres of tree plantations in the Vicksburg District. The estimated net impacts in AAHU's for Plans 3 and 4 by District are presented in Table 10-4. These impacts were summarized from the HEP Forms C and D contained in Attachment A. Negative results indicate net loss of AAHU's, and positive results indicate net gains of AAHU's. There were losses in AAHU's for each evaluation species except mink. Habitat for this species was increased in the project area due to an increase in acres of permanent water bordered by woodlands. In addition, an increase in borrow area edge provided some additional wood duck habitat in the project area and this reduced the loss of forested habitat for this species to some extent. The results of the impacts of each alternative by District have been combined into the overall effects for the entire project area (Table 10-5). Implementation of Plan 3 would result in the total loss of 19,565 AAHU's. The plan that includes design measures to avoid and minimize environmental impacts to riverside woodlands and wetlands (Plan 4), without compensation measures, would result in the total loss of 6,581 AAHU's. Implementation of compensation measures as a feature of Plan 4 would eliminate the loss of these units.

TABLE 10-4
NET CHANGE IN AAHU'S a/

Species	Plan 3 (AAHU's)	Plan 4 (AAHUs)
Memphis District		
Barred owl	-1,785.93	-280.75
Fox squirrel	-826.05	-234.74
Carolina chickadee	-2,400.56	-406.21
Pileated woodpecker	-919.81	-141.09
Mink	0.0	+ 31.26
Wood duck	-1,112.93	-131.76
Total Combined AAHU's	-7,045.28	-1,163.29
Vicksburg District		
Barred owl	-3,965.13	-1,864.62
Fox squirrel	-3,767.02	-1,728.86
Carolina chickadee	-4,728.45	-2,182.38
Pileated woodpecker	-2,068.70	-954.79
Mink	+4,530.62	+2,058.68
Wood duck	-2,516.96	-1,021.9
Total Combined AAHU's	-12,515.64	-5,693.87
New Orleans District		
Barred owl	-6.0	-6.0
Fox squirrel	-2.0	-2.0
Carolina chickadee	-8.0	-8.0
Pileated woodpecker	0.0	0.0
Mink	+12.0	+12.0
Wood duck	0.0	0.0
Total combined AAHU's	-4.0	-4.0

a/ A minus denotes a loss in AAHU's and a plus denotes a gain in AAHU's.

TABLE 10-5
NET CHANGES IN AAHU'S IN THE PROJECT AREA a/

Species	Plan 3 (AAHU's)	Plan 4 (AAHU's)
Barred owl	-5,757.06	-2,151.37
Fox squirrel	-4,595.07	-1,965.60
Carolina chickadee	-7,137.01	-2,596.59
Pileated woodpecker	-2,988.45	-1,095.88
Mink	+4,542.62	+2,101.94
Wood duck	-3,629.89	-1,016.00
Total Combined AAHU's	-19,564.86	-6,861.16

a/ A minus denotes a loss in AAHU's and a plus denotes a gain in AAHU's.

COMPENSATION ANALYSIS

EXAMPLE MANAGEMENT PLANS

45. The AAHU's that could be gained by reestablishing bottom-land hardwood forest on 100 acres of cleared land under various management plans are given in Table 10-6. Benefits of eight different management plans were estimated for selected target years over the life of the project using models developed by consensus of the HEP team for the project.

46. The MRL project has a relative long economic lifespan (100 years). All construction work is expected to be completed within the next 23 years; however, this analysis considers the effects of the construction on the environment during the construction period and for the remainder of the project lifespan (77 years). The compensation measures to eliminate adverse effects to significant resources in the project area have also been analyzed for the project life. This process ensures that the magnitude and duration of adverse environmental effects have been measured and offset.

47. Pertinent aspects of each management plan formulated to compensate for unavoidable losses for Plan 4 follow. Management plans (MP1 and MP2) assume that certain borrow areas in the project area would be drained to the Mississippi River and be either allowed to revert to woodlands naturally, or be actively reforested using seedlings. These plans provide substantial benefits to all evaluation species except mink. Management plans (MP3 and MP6) apply only to cleared sites on the Mississippi River flood plain that do not have any significant amounts of permanent water or seasonally flooding of long duration so that no habitat would be provided for two evaluation species (wood duck and mink). Management plans (MP4 and MP7) apply to sites that have similar amounts of permanent water present as those areas impacted. In addition, these lands should not be seasonally flooded any longer than the lands of the project area. These plans provide benefits to all evaluation species except mink. Management plans (MP5 and MP8) apply to cleared lands within 328 feet of lake or stream containing surface water equal to, or greater than, 9 months per year. Both of these plans provide benefits to all evaluation species.

TABLE 10-6
ESTIMATED BENEFITS OF ESTABLISHMENT OF BOTTOM-LAND FORESTS
UNDER VARIOUS MANAGEMENT PLANS
(Increase in AAHU's per 100 Acres Management)

Plan	Barred Owl	Fox Squirrel	Carolina Chickadee	Pileated Woodpecker	Mink	Duck	Total
Natural Succession							
MP1	43.25	29.05	41.74	41.55	0.0	48.60	204.19
Active Reforestation							
MP2	50.25	58.04	51.84	51.20	0.0	52.07	263.40
Reforested Flood Plain							
Natural Succession							
MP3	60.00	37.65	48.00	55.65	0.00	0.00	201.30
MP4	60.00	37.65	48.00	55.65	0.00	10.58	211.88
MP5	60.00	37.65	48.00	55.65	41.58	10.58	253.40
Active Reforestation							
MP6	60.00	65.35	48.00	55.65	0.00	0.00	228.90
MP7	60.00	65.25	48.00	55.65	0.00	65.70	294.60
MP8	60.00	65.25	48.00	55.65	41.58	65.70	336.18

MP1 and MP2 - These management plans are calculated for reforesting drained borrow areas in the project area. MP1 reveals the AAHU's per 100 acres of land was allowed to revert to woods naturally. MP2 reveals the AAHU's gained per 100 acres of land that would result from actively reforesting drained borrow areas. No benefits accrue to mink unless the site is within 328 feet of a lake or stream.
MP3 and MP6 - These plans apply to sites on a flood plain that do not have any significant amounts of permanent water or seasonal flooding.
MP4 and MP7 - These plans apply to sites on the flood plain that have similar amounts of permanent water as the project area.
MP5 and MP8 - These plans apply to sites within 328 feet of a lake or stream containing surface water equal to or greater than 9 months per year. Abundant shoreline cover is expected to be present.

COMPENSATION

48. Compensation for Plan 4 can be estimated by dividing total AAHU losses calculated for Plan 4 by the potential AAHU benefits of a management plan and multiplying by 100. For example, complete compensation for project-induced habitat losses would require 3,408 acres of reforestation under MP3 ([6,861/201.3] x 100). Complete compensation for project-induced terrestrial habitat losses would require between 2,041 and 3,408 acres of reforestation depending upon the time of reforestation, the proximity and permanence of water at the reforestation site, and the method of reforestation.

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ATTACHMENT A

HEP FORMS C AND D
PROJECT IMPACTS

MEMPHIS DISTRICT
HEP FORMS

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MINK
Action: PA 1 (without project) WITHOUT PROJECT
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 1738.26

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	2997.00	0.58	1738.26
1	2997.00	0.58	1738.26
6	2997.00	0.58	1738.26
17	2997.00	0.58	1738.26
100	2997.00	0.58	1738.26

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MINK
Action: PA 2 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 1769.52

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	2997.00	0.58	1738.26
1	2997.00	0.58	1738.26
6	3007.00	0.58	1744.06
17	3057.00	0.58	1773.06
100	3057.00	0.58	1773.06

Form D: Net Change in AAHU's Date: 12/01/1997

Study Name: MINK
Action: PA 2 (with project) PLAN 4
Compared To: PA 1 (without project) WITHOUT PROJECT
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	MINK	1769.52	1738.26	31.26

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 3 (without project) WITHOUT PROJECT
Life of Project: 100
Evaluation Species: 2 WOOD DUCK AAHU's: 379.29

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	807.00	0.47	379.29
1	807.00	0.47	379.29
6	807.00	0.47	379.29
17	807.00	0.47	379.29
100	807.00	0.47	379.29

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 4 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 2 WOOD DUCK AAHU's: 385.19

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	807.00	0.47	379.29
1	807.00	0.47	379.29
6	809.00	0.47	380.23
17	821.00	0.47	385.87
100	821.00	0.47	385.87

Form D: Net Change in AAHU's

Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 4 (with project) PLAN 4
Compared To: PA 3 (without project) WITHOUT PROJECT
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
2	WOOD DUCK	385.19	379.29	5.90

Form C: Average Annual Habitat Units　　　　Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) WITHOUT PROJECT (RS)
Life of Project: 100
Evaluation Species: 2 WOOD DUCK　　　　AAHU's: 162424.95

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.47	162424.95
1	345585.00	0.47	162424.95
2	345585.00	0.47	162424.95
17	345585.00	0.47	162424.95
100	345585.00	0.47	162424.95

Form C: Average Annual Habitat Units　　　　Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) WITHOUT PROJECT (RS)
Life of Project: 100
Evaluation Species: 3 PILEATED WOODPECKER　　　　AAHU's: 120954.75

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.35	120954.75
1	345585.00	0.35	120954.75
2	345585.00	0.35	120954.75
17	345585.00	0.35	120954.75
100	345585.00	0.35	120954.75

Form C: Average Annual Habitat Units　　　　Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) WITHOUT PROJECT (RS)
Life of Project: 100
Evaluation Species: 4 BARRED OWL　　　　AAHU's: 231541.96

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.67	231541.96
1	345585.00	0.67	231541.96
2	345585.00	0.67	231541.96
17	345585.00	0.67	231541.96
100	345585.00	0.67	231541.96

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) WITHOUT PROJECT (RS)
Life of Project: 100
Evaluation Species: 5 CAROLINA CHICKADEE AAHU's: 297203.10

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.86	297203.10
1	345585.00	0.86	297203.10
2	345585.00	0.86	297203.10
17	345585.00	0.86	297203.10
100	345585.00	0.86	297203.10

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) WITHOUT PROJECT (RS)
Life of Project: 100
Evaluation Species: 6 FOX SQUIRREL AAHU's: 138234.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.40	138234.00
1	345585.00	0.40	138234.00
2	345585.00	0.40	138234.00
17	345585.00	0.40	138234.00
100	345585.00	0.40	138234.00

Form C: Average Annual Habitat Units — Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (with project) PLAN 3 (RS)
Life of Project: 100
Evaluation Species: 2 WOOD DUCK — AAHU's: 161312.02

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.47	162424.95
1	345585.00	0.47	162424.95
2	345387.00	0.47	162331.89
17	342986.00	0.47	161203.42
100	342986.00	0.47	161203.42

Form C: Average Annual Habitat Units — Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (with project) PLAN 3 (RS)
Life of Project: 100
Evaluation Species: 3 PILEATED WOODPECKER — AAHU's: 120125.97

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.35	120954.75
1	345585.00	0.35	120954.75
2	345387.00	0.35	120885.45
17	342986.00	0.35	120045.10
100	342986.00	0.35	120045.10

Form C: Average Annual Habitat Units — Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (with project) PLAN 3 (RS)
Life of Project: 100
Evaluation Species: 4 BARRED OWL — AAHU's: 229955.44

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.67	231541.96
1	345585.00	0.67	231541.96
2	345387.00	0.67	231409.30
17	342986.00	0.67	229800.63
100	342986.00	0.67	229800.63

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (with project) PLAN 3 (RS)
Life of Project: 100
Evaluation Species: 5 CAROLINA CHICKADEE AAHU's: 295166.68

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.86	297203.10
1	345585.00	0.86	297203.10
2	345387.00	0.86	297032.82
17	342986.00	0.86	294967.96
100	342986.00	0.86	294967.96

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (with project) PLAN 3 (RS)
Life of Project: 100
Evaluation Species: 6 FOX SQUIRREL AAHU's: 137685.39

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.40	138234.00
1	345585.00	0.40	138234.00
2	345387.00	0.40	138154.80
17	342986.00	0.40	137194.40
100	345387.00	0.40	138154.80

Form C: Average Annual Habitat Units | Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4 (RS)
Life of Project: 100
Evaluation Species: 2 WOOD DUCK | AAHU's: 162287.29

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.47	162424.95
1	345585.00	0.47	162424.95
2	345442.00	0.47	162357.74
17	345274.00	0.47	162278.78
100	345274.00	0.47	162278.78

Form C: Average Annual Habitat Units | Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4 (RS)
Life of Project: 100
Evaluation Species: 3 PILEATED WOODPECKER | AAHU's: 120852.23

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.35	120954.75
1	345585.00	0.35	120954.75
2	345442.00	0.35	120904.70
17	345274.00	0.35	120845.90
100	345274.00	0.35	120845.90

Form C: Average Annual Habitat Units | Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4 (RS)
Life of Project: 100
Evaluation Species: 4 BARRED OWL | AAHU's: 231345.72

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.67	231541.96
1	345585.00	0.67	231541.96
2	345442.00	0.67	231446.15
17	345274.00	0.67	231333.59
100	345274.00	0.67	231333.59

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4 (RS)
Life of Project: 100
Evaluation Species: 5 CAROLINA CHICKADEE AAHU's: 296951.22

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.86	297203.10
1	345585.00	0.86	297203.10
2	345442.00	0.86	297080.12
17	345274.00	0.86	296935.64
100	345274.00	0.86	296935.64

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4 (RS)
Life of Project: 100
Evaluation Species: 6 FOX SQUIRREL AAHU's: 138116.84

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	345585.00	0.40	138234.00
1	345585.00	0.40	138234.00
2	345442.00	0.40	138176.80
17	345274.00	0.40	138109.60
100	345274.00	0.40	138109.60

Form D: Net Change in AAHU's

Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (with project) PLAN 3 (RS)
Compared To: PA 5 (without project) WITHOUT PROJECT (RS)
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
2	WOOD DUCK	161312.02	162424.95	-1112.93
3	PILEATED WOODPECKER	120125.97	120954.75	-828.78
4	BARRED OWL	229955.44	231541.96	-1586.52
5	CAROLINA CHICKADEE	295166.68	297203.10	-2036.42
6	FOX SQUIRREL	137685.39	138234.00	-548.61

Form D: Net Change in AAHU's

Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4 (RS)
Compared To: PA 5 (without project) WITHOUT PROJECT (RS)
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
2	WOOD DUCK	162287.29	162424.95	-137.66
3	PILEATED WOODPECKER	120852.23	120954.75	-102.51
4	BARRED OWL	231345.72	231541.96	-196.24
5	CAROLINA CHICKADEE	296951.22	297203.10	-251.89
6	FOX SQUIRREL	138116.84	138234.00	-117.16

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (without project) WITHOUT PROJECT (LS)
Life of Project: 100
Evaluation Species: 3 PILEATED WOODPECKER AAHU's: 5055.75

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.21	5055.75
1	24075.00	0.21	5055.75
2	24075.00	0.21	5055.75
17	24075.00	0.21	5055.75
100	24075.00	0.21	5055.75

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (without project) WITHOUT PROJECT (LS)
Life of Project: 100
Evaluation Species: 4 BARRED OWL AAHU's: 11074.50

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.46	11074.50
1	24075.00	0.46	11074.50
2	24075.00	0.46	11074.50
17	24075.00	0.46	11074.50
100	24075.00	0.46	11074.50

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (without project) WITHOUT PROJECT (LS)
Life of Project: 100
Evaluation Species: 5 CAROLINA CHICKADEE AAHU's: 20223.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.84	20223.00
1	24075.00	0.84	20223.00
2	24075.00	0.84	20223.00
17	24075.00	0.84	20223.00
100	24075.00	0.84	20223.00

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (without project) WITHOUT PROJECT (LS)
Life of Project: 100
Evaluation Species: 6 FOX SQUIRREL AAHU's: 15408.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.64	15408.00
1	24075.00	0.64	15408.00
2	24075.00	0.64	15408.00
17	24075.00	0.64	15408.00
100	24075.00	0.64	15408.00

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (with project) PLAN 3 (LS)
Life of Project: 100
Evaluation Species: 3 PILEATED WOODPECKER AAHU's: 4964.72

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.21	5055.75
1	24075.00	0.21	5055.75
2	24075.00	0.21	5055.75
17	23596.00	0.21	4955.16
100	23596.00	0.21	4955.16

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (with project) PLAN 3 (LS)
Life of Project: 100
Evaluation Species: 4 BARRED OWL AAHU's: 10875.09

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.46	11074.50
1	24075.00	0.46	11074.50
2	24075.00	0.46	11074.50
17	23596.00	0.46	10854.16
100	23596.00	0.46	10854.16

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (with project) PLAN 3 (LS)
Life of Project: 100
Evaluation Species: 5 CAROLINA CHICKADEE AAHU's: 19858.86

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.84	20223.00
1	24075.00	0.84	20223.00
2	24075.00	0.84	20223.00
17	23596.00	0.84	19820.64
100	23596.00	0.84	19820.64

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (with project) PLAN 3 (LS)
Life of Project: 100
Evaluation Species: 6 FOX SQUIRREL AAHU's: 15130.56

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.64	15408.00
1	24075.00	0.64	15408.00
2	24075.00	0.64	15408.00
17	23596.00	0.64	15101.44
100	23596.00	0.64	15101.44

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (with project) PLAN 4 (LS)
Life of Project: 100
Evaluation Species: 3 PILEATED WOODPECKER AAHU's: 5017.17

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.21	5055.75
1	24075.00	0.21	5055.75
2	24075.00	0.21	5055.75
17	23872.00	0.21	5013.12
100	23872.00	0.21	5013.12

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (with project) PLAN 4 (LS)
Life of Project: 100
Evaluation Species: 4 BARRED OWL AAHU's: 10989.99

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.46	11074.50
1	24075.00	0.46	11074.50
2	24075.00	0.46	11074.50
17	23872.00	0.46	10981.12
100	23872.00	0.46	10981.12

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (with project) PLAN 4 (LS)
Life of Project: 100
Evaluation Species: 5 CAROLINA CHICKADEE AAHU's: 20068.68

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.84	20223.00
1	24075.00	0.84	20223.00
2	24075.00	0.84	20223.00
17	23872.00	0.84	20052.48
100	23872.00	0.84	20052.48

Form C: Average Annual Habitat Units Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (with project) PLAN 4 (LS)
Life of Project: 100
Evaluation Species: 6 FOX SQUIRREL AAHU's: 15290.42

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	24075.00	0.64	15408.00
1	24075.00	0.64	15408.00
2	24075.00	0.64	15408.00
17	23872.00	0.64	15278.08
100	23872.00	0.64	15278.08

Form D: Net Change in AAHU's Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (with project) PLAN 3 (LS)
Compared To: PA 8 (without project) WITHOUT PROJECT (LS)
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
3	PILEATED WOODPECKER	4964.72	5055.75	-91.03
4	BARRED OWL	10875.09	11074.50	-199.41
5	CAROLINA CHICKADEE	19858.86	20223.00	-364.14
6	FOX SQUIRREL	15130.56	15408.00	-277.44

Form D: Net Change in AAHU's

Date: 12/01/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (with project) PLAN 4 (LS)
Compared To: PA 8 (without project) WITHOUT PROJECT (LS)
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
3	PILEATED WOODPECKER	5017.17	5055.75	-38.58
4	BARRED OWL	10989.99	11074.50	-84.51
5	CAROLINA CHICKADEE	20068.68	20223.00	-154.32
6	FOX SQUIRREL	15290.42	15408.00	-117.58

VICKSBURG DISTRICT
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Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 134315.16

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.28	134315.16
1	479697.00	0.28	134315.16
23	479697.00	0.28	134315.16
100	479697.00	0.28	134315.16

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 191878.80

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.40	191878.80
1	479697.00	0.40	191878.80
23	479697.00	0.40	191878.80
100	479697.00	0.40	191878.80

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 1402.28

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.04	1402.28
1	35057.00	0.04	1402.28
23	35057.00	0.04	1402.28
100	35057.00	0.04	1402.28

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 701.14

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.02	701.14
1	35057.00	0.02	701.14
23	35057.00	0.02	701.14
100	35057.00	0.02	701.14

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.00	0.00
1	35057.00	0.00	0.00
23	35057.00	0.00	0.00
100	35057.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.00	0.00
1	35057.00	0.00	0.00
23	35057.00	0.00	0.00
100	35057.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 10 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.00	0.00
1	35057.00	0.00	0.00
23	35057.00	0.00	0.00
100	35057.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 11 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 255272.72

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.54	258868.45
1	479051.00	0.54	258687.55
23	471863.00	0.54	254806.03
100	471863.00	0.54	254806.03

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 11 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 245818.15

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.52	249280.71
1	479051.00	0.52	249106.51
23	471863.00	0.52	245368.75
100	471863.00	0.52	245368.75

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 11 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 302545.42

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.64	306807.03
1	479051.00	0.64	306592.63
23	471863.00	0.64	301992.31
100	471863.00	0.64	301992.31

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 11 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 132363.63

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.28	134228.08
1	479051.00	0.28	134134.28
23	471863.00	0.28	132121.64
100	471863.00	0.28	132121.64

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 11 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 189090.90

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.40	191754.40
1	479051.00	0.40	191620.40
23	471863.00	0.40	188745.20
100	471863.00	0.40	188745.20

Form C: Average Annual Habitat Units   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 12 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 1 BARRED OWL   AAHU's: 1381.07

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.04	1388.80
1	34708.00	0.04	1388.32
23	34502.00	0.04	1380.08
100	34502.00	0.04	1380.08

Form C: Average Annual Habitat Units   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 12 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL   AAHU's: 690.54

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.02	694.40
1	34708.00	0.02	694.16
23	34502.00	0.02	690.04
100	34502.00	0.02	690.04

Form C: Average Annual Habitat Units   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 12 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE   AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.00	0.00
1	34708.00	0.00	0.00
23	34502.00	0.00	0.00
100	34502.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 12 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.00	0.00
1	34708.00	0.00	0.00
23	34502.00	0.00	0.00
100	34502.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 12 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.00	0.00
1	34708.00	0.00	0.00
23	34502.00	0.00	0.00
100	34502.00	0.00	0.00

Form D: Net Change in AAHU's Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 11 (with project) PLAN 3
Compared To: PA 9 (without project) PLAN 3
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	255272.72	259036.39	-3763.67
2	FOX SQUIRREL	245818.15	249442.43	-3624.28
3	CAROLINA CHICKADEE	302545.42	307006.07	-4460.65
4	PILEATED WOODPECKER	132363.63	134315.16	-1951.53
5	WOOD DUCK	189090.90	191878.80	-2787.91

Form D: Net Change in AAHU's Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 12 (with project) PLAN 3
Compared To: PA 10 (without project) PLAN 3
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	1381.07	1402.28	-21.21
2	FOX SQUIRREL	690.54	701.14	-10.60
3	CAROLINA CHICKADEE	0.00	0.00	0.00
4	PILEATED WOODPECKER	0.00	0.00	0.00
5	WOOD DUCK	0.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 13 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 17766.42

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.49	17766.42
1	36258.00	0.49	17766.42
23	36258.00	0.49	17766.42
100	36258.00	0.49	17766.42

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 13 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 13778.04

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.38	13778.04
1	36258.00	0.38	13778.04
23	36258.00	0.38	13778.04
100	36258.00	0.38	13778.04

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 13 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 23205.12

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.64	23205.12
1	36258.00	0.64	23205.12
23	36258.00	0.64	23205.12
100	36258.00	0.64	23205.12

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 13 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 10152.24

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.28	10152.24
1	36258.00	0.28	10152.24
23	36258.00	0.28	10152.24
100	36258.00	0.28	10152.24

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 13 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 2538.06

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.07	2538.06
1	36258.00	0.07	2538.06
23	36258.00	0.07	2538.06
100	36258.00	0.07	2538.06

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 14 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 53.52

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.04	53.52
1	1338.00	0.04	53.52
23	1338.00	0.04	53.52
100	1338.00	0.04	53.52

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 14 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 26.76

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.02	26.76
1	1338.00	0.02	26.76
23	1338.00	0.02	26.76
100	1338.00	0.02	26.76

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 14 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1338.00	0.00	0.00
23	1338.00	0.00	0.00
100	1338.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 14 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1338.00	0.00	0.00
23	1338.00	0.00	0.00
100	1338.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 14 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1338.00	0.00	0.00
23	1338.00	0.00	0.00
100	1338.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 15 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 17476.83

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.49	17766.42
1	36131.00	0.49	17704.19
23	35603.00	0.49	17445.47
100	35603.00	0.49	17445.47

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 15 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 13553.46

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.38	13778.04
1	36131.00	0.38	13729.78
23	35603.00	0.38	13529.14
100	35603.00	0.38	13529.14

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 15 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 22826.88

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.64	23205.12
1	36131.00	0.64	23123.84
23	35603.00	0.64	22785.92
100	35603.00	0.64	22785.92

Form C: Average Annual Habitat Units   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 15 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER   AAHU's: 9986.76

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.28	10152.24
1	36131.00	0.28	10116.68
23	35603.00	0.28	9968.84
100	35603.00	0.28	9968.84

Form C: Average Annual Habitat Units   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 15 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 5 WOOD DUCK   AAHU's: 2496.69

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.07	2538.06
1	36131.00	0.07	2529.17
23	35603.00	0.07	2492.21
100	35603.00	0.07	2492.21

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 16 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 50.65

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.04	53.52
1	1334.00	0.04	53.36
23	1257.00	0.04	50.28
100	1257.00	0.04	50.28

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 16 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 25.33

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.02	26.76
1	1334.00	0.02	26.68
23	1257.00	0.02	25.14
100	1257.00	0.02	25.14

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 16 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1334.00	0.00	0.00
23	1257.00	0.00	0.00
100	1257.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 16 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1334.00	0.00	0.00
23	1257.00	0.00	0.00
100	1257.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 16 (with project) PLAN 3
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1334.00	0.00	0.00
23	1257.00	0.00	0.00
100	1257.00	0.00	0.00

Form D: Net Change in AAHU's   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 15 (with project) PLAN 3
Compared To: PA 13 (without project) PLAN 3
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	17476.83	17766.42	-289.59
2	FOX SQUIRREL	13553.46	13778.04	-224.58
3	CAROLINA CHICKADEE	22826.88	23205.12	-378.24
4	PILEATED WOODPECKER	9986.76	10152.24	-165.48
5	WOOD DUCK	2496.69	2538.06	-41.37

Form D: Net Change in AAHU's   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 16 (with project) PLAN 3
Compared To: PA 14 (without project) PLAN 3
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	50.65	53.52	-2.87
2	FOX SQUIRREL	25.33	26.76	-1.43
3	CAROLINA CHICKADEE	0.00	0.00	0.00
4	PILEATED WOODPECKER	0.00	0.00	0.00
5	WOOD DUCK	0.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 09/30/1997

Study Name: WOOD DUCK EVALUATION
Action: PA 30 (without project) WOOD DUCK
Life of Project: 100
Evaluation Species: 1 WOOD DUCK AAHU's: 1049.60

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	2624.00	0.40	1049.60
1	2624.00	0.40	1049.60
23	2624.00	0.40	1049.60
100	2624.00	0.40	1049.60

Form C: Average Annual Habitat Units   Date: 09/30/1997

Study Name: WOOD DUCK EVALUATION
Action: PA 31 (with project) WOOD DUCK
Life of Project: 100
Evaluation Species: 1 WOOD DUCK   AAHU's: 1308.30

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	2624.00	0.40	1049.60
1	2769.00	0.40	1107.60
23	3340.00	0.40	1336.00
100	3340.00	0.40	1336.00

Form D: Net Change in AAHU's Date: 09/30/1997

Study Name: WOOD DUCK EVALUATION
Action: PA 31 (with project) WOOD DUCK
Compared To: PA 30 (without project) WOOD DUCK
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	WOOD DUCK	1308.30	1049.60	258.70

Form C: Average Annual Habitat Units   Date: 09/25/1997

Study Name: PLAN3 MINK EVAL
Action: PA 9 (without project) EVAL MINK
Life of Project: 100
Evaluation Species: 1 MINK   AAHU's: 7474.00

Target Year	Area of Habitat		Habitat Suitability Index	Habitat Units
0	10100.00	+942	0.74	7474.00
1	10100.00		0.74	7474.00
23	10100.00		0.74	7474.00
100	10100.00		0.74	7474.00

Form C: Average Annual Habitat Units Date: 09/25/1997

Study Name: PLAN3 MINK EVAL
Action: PA 10 (with project) EVAL MINK
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 12004.62

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10100.00	0.74	7474.00
1	10401.00	0.74	7696.74
23	17018.00	0.74	12593.32
100	17018.00	0.74	12593.32

Form D: Net Change in AAHU's Date: 09/25/1997

Study Name: PLAN3 MINK EVAL
Action: PA 10 (with project) EVAL MINK
Compared To: PA 9 (without project) EVAL MINK
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	MINK	12004.62	7474.00	4530.62

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 259036.39

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.54	259036.39
1	479697.00	0.54	259036.39
23	479697.00	0.54	259036.39
100	479697.00	0.54	259036.39

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 249442.43

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.52	249442.43
1	479697.00	0.52	249442.43
23	479697.00	0.52	249442.43
100	479697.00	0.52	249442.43

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 307006.07

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.64	307006.07
1	479697.00	0.64	307006.07
23	479697.00	0.64	307006.07
100	479697.00	0.64	307006.07

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 134315.16

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.28	134315.16
1	479697.00	0.28	134315.16
23	479697.00	0.28	134315.16
100	479697.00	0.28	134315.16

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 191878.80

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.40	191878.80
1	479697.00	0.40	191878.80
23	479697.00	0.40	191878.80
100	479697.00	0.40	191878.80

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (without project) PLAN4
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 1402.28

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.04	1402.28
1	35057.00	0.04	1402.28
23	35057.00	0.04	1402.28
100	35057.00	0.04	1402.28

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (without project) PLAN4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 701.14

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.02	701.14
1	35057.00	0.02	701.14
23	35057.00	0.02	701.14
100	35057.00	0.02	701.14

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (without project) PLAN4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.00	0.00
1	35057.00	0.00	0.00
23	35057.00	0.00	0.00
100	35057.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (without project) PLAN4
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.00	0.00
1	35057.00	0.00	0.00
23	35057.00	0.00	0.00
100	35057.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (without project) PLAN4
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	35057.00	0.00	0.00
1	35057.00	0.00	0.00
23	35057.00	0.00	0.00
100	35057.00	0.00	0.00

Form C: Average Annual Habitat Units — Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 3 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL — AAHU's: 257229.12

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.54	258868.45
1	479051.00	0.54	258687.55
23	475980.00	0.54	257029.21
100	475980.00	0.54	257029.21

Form C: Average Annual Habitat Units — Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 3 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL — AAHU's: 247702.09

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.52	249280.71
1	479051.00	0.52	249106.51
23	475980.00	0.52	247509.59
100	475980.00	0.52	247509.59

Form C: Average Annual Habitat Units — Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 3 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE — AAHU's: 304864.12

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.64	306807.03
1	479051.00	0.64	306592.63
23	475980.00	0.64	304627.19
100	475980.00	0.64	304627.19

Form C: Average Annual Habitat Units   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 3 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER   AAHU's: 133378.06

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.28	134228.08
1	479051.00	0.28	134134.28
23	475980.00	0.28	133274.40
100	475980.00	0.28	133274.40

Form C: Average Annual Habitat Units   Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 3 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 5 WOOD DUCK   AAHU's: 190540.08

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479386.00	0.40	191754.40
1	479051.00	0.40	191620.40
23	475980.00	0.40	190392.00
100	475980.00	0.40	190392.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 4 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 1363.86

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.04	1388.80
1	34708.00	0.04	1388.32
23	34013.00	0.04	1360.52
100	34013.00	0.04	1360.52

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 4 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 681.93

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.02	694.40
1	34708.00	0.02	694.16
23	34013.00	0.02	680.26
100	34013.00	0.02	680.26

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 4 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.00	0.00
1	34708.00	0.00	0.00
23	34013.00	0.00	0.00
100	34013.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 4 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.00	0.00
1	34708.00	0.00	0.00
23	34013.00	0.00	0.00
100	34013.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 4 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	34720.00	0.00	0.00
1	34708.00	0.00	0.00
23	34013.00	0.00	0.00
100	34013.00	0.00	0.00

Form D: Net Change in AAHU's

Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 3 (with project) PLAN 4
Compared To: PA 1 (without project) PLAN 4
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	257229.12	259036.39	-1807.27
2	FOX SQUIRREL	247702.09	249442.43	-1740.34
3	CAROLINA CHICKADEE	304864.12	307006.07	-2141.96
4	PILEATED WOODPECKER	133378.06	134315.16	-937.11
5	WOOD DUCK	190540.08	191878.80	-1338.72

Form D: Net Change in AAHU's Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 4 (with project) PLAN 4
Compared To: PA 2 (without project) PLAN4
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	1363.86	1402.28	-38.42
2	FOX SQUIRREL	681.93	701.14	-19.21
3	CAROLINA CHICKADEE	0.00	0.00	0.00
4	PILEATED WOODPECKER	0.00	0.00	0.00
5	WOOD DUCK	0.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 17766.42

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.49	17766.42
1	36258.00	0.49	17766.42
23	36258.00	0.49	17766.42
100	36258.00	0.49	17766.42

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 13778.04

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.38	13778.04
1	36258.00	0.38	13778.04
23	36258.00	0.38	13778.04
100	36258.00	0.38	13778.04

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 23205.12

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.64	23205.12
1	36258.00	0.64	23205.12
23	36258.00	0.64	23205.12
100	36258.00	0.64	23205.12

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 10152.24

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.28	10152.24
1	36258.00	0.28	10152.24
23	36258.00	0.28	10152.24
100	36258.00	0.28	10152.24

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 5 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 2538.06

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.07	2538.06
1	36258.00	0.07	2538.06
23	36258.00	0.07	2538.06
100	36258.00	0.07	2538.06

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 53.52

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.04	53.52
1	1338.00	0.04	53.52
23	1338.00	0.04	53.52
100	1338.00	0.04	53.52

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 26.76

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.02	26.76
1	1338.00	0.02	26.76
23	1338.00	0.02	26.76
100	1338.00	0.02	26.76

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1338.00	0.00	0.00
23	1338.00	0.00	0.00
100	1338.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1338.00	0.00	0.00
23	1338.00	0.00	0.00
100	1338.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 6 (without project) PLAN 4
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1338.00	0.00	0.00
23	1338.00	0.00	0.00
100	1338.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 17502.70

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.49	17766.42
1	36131.00	0.49	17704.19
23	35663.00	0.49	17474.87
100	35663.00	0.49	17474.87

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 13573.52

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.38	13778.04
1	36131.00	0.38	13729.78
23	35663.00	0.38	13551.94
100	35663.00	0.38	13551.94

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 22860.67

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.64	23205.12
1	36131.00	0.64	23123.84
23	35663.00	0.64	22824.32
100	35663.00	0.64	22824.32

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 10001.54

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.28	10152.24
1	36131.00	0.28	10116.68
23	35663.00	0.28	9985.64
100	35663.00	0.28	9985.64

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 2500.39

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	36258.00	0.07	2538.06
1	36131.00	0.07	2529.17
23	35663.00	0.07	2496.41
100	35663.00	0.07	2496.41

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 51.35

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.04	53.52
1	1326.00	0.04	53.04
23	1278.00	0.04	51.12
100	1278.00	0.04	51.12

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 25.68

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.02	26.76
1	1326.00	0.02	26.52
23	1278.00	0.02	25.56
100	1278.00	0.02	25.56

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1326.00	0.00	0.00
23	1278.00	0.00	0.00
100	1278.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 4 PILEATED WOODPECKER AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1326.00	0.00	0.00
23	1278.00	0.00	0.00
100	1278.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (with project) PLAN 4
Life of Project: 100
Evaluation Species: 5 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1338.00	0.00	0.00
1	1326.00	0.00	0.00
23	1278.00	0.00	0.00
100	1278.00	0.00	0.00

Form D: Net Change in AAHU's

Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 7 (with project) PLAN 4
Compared To: PA 5 (without project) PLAN 4
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	17502.70	17766.42	-263.72
2	FOX SQUIRREL	13573.52	13778.04	-204.52
3	CAROLINA CHICKADEE	22860.67	23205.12	-344.45
4	PILEATED WOODPECKER	10001.54	10152.24	-150.70
5	WOOD DUCK	2500.39	2538.06	-37.67

Form D: Net Change in AAHU's Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 8 (with project) PLAN 4
Compared To: PA 6 (without project) PLAN 4
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	51.35	53.52	-2.17
2	FOX SQUIRREL	25.68	26.76	-1.08
3	CAROLINA CHICKADEE	0.00	0.00	0.00
4	PILEATED WOODPECKER	0.00	0.00	0.00
5	WOOD DUCK	0.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 11/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) WOOD DUCK EDGE
Life of Project: 100
Evaluation Species: 1 WOOD DUCK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1242.00	0.00	0.00
1	1242.00	0.00	0.00
100	1242.00	0.00	0.00

Form C: Average Annual Habitat Units   Date: 11/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project)   WOOD DUCK EDGE
Life of Project: 100
Evaluation Species: 1 WOOD DUCK   AAHU's: 496.80

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	1242.00	0.40	496.80
1	1242.00	0.40	496.80
100	1242.00	0.40	496.80

Form D: Net Change in AAHU's

Date: 11/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project) WOOD DUCK EDGE
Compared To: PA 1 (without project) WOOD DUCK EDGE
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	WOOD DUCK	496.80	0.00	496.80

Form C: Average Annual Habitat Units Date: 11/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) MINK EDGE
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 0.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	2782.00	0.00	0.00
1	2782.00	0.00	0.00
100	2782.00	0.00	0.00

Form C: Average Annual Habitat Units Date: 11/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project) MINK EDGE
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 2058.68

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	2782.00	0.74	2058.68
1	2782.00	0.74	2058.68
100	2782.00	0.74	2058.68

Form D: Net Change in AAHU's Date: 11/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project) MINK EDGE
Compared To: PA 1 (without project) MINK EDGE
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	MINK	2058.68	0.00	2058.68

Form C: Average Annual Habitat Units Date: 01/03/1998

Study Name: PLAN3 MINK EVAL
Action: PA 9 (without project) EVAL MINK
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 7474.00

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10100.00	0.74	7474.00
1	10100.00	0.74	7474.00
23	10100.00	0.74	7474.00
100	10100.00	0.74	7474.00

Form C: Average Annual Habitat Units Date: 01/03/1998

Study Name: PLAN3 MINK EVAL
Action: PA 10 (with project) EVAL MINK
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 12004.62

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	10100.00	0.74	7474.00
1	10401.00	0.74	7696.74
23	17018.00	0.74	12593.32
100	17018.00	0.74	12593.32

Form D: Net Change in AAHU's   Date: 01/03/1998

Study Name: PLAN3 MINK EVAL
Action: PA 10 (with project) EVAL MINK
Compared To: PA 9 (without project) EVAL MINK
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	MINK	12004.62	7474.00	4530.62

NEW ORLEANS DISTRICT
HEP FORMS

Form C: Average Annual Habitat Units Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLANS 3AND 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 68023.80

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	188955.00	0.36	68023.80
1	188955.00	0.36	68023.80
8	188955.00	0.36	68023.80
25	188955.00	0.36	68023.80
50	188955.00	0.36	68023.80
100	188955.00	0.36	68023.80

Form C: Average Annual Habitat Units Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLANS 3AND 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 24564.15

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	188955.00	0.13	24564.15
1	188955.00	0.13	24564.15
8	188955.00	0.13	24564.15
25	188955.00	0.13	24564.15
50	188955.00	0.13	24564.15
100	188955.00	0.13	24564.15

Form C: Average Annual Habitat Units Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLANS 3AND 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 90698.40

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	188955.00	0.48	90698.40
1	188955.00	0.48	90698.40
8	188955.00	0.48	90698.40
25	188955.00	0.48	90698.40

50	188955.00	0.48	90698.40
100	188955.00	0.48	90698.40

Form C: Average Annual Habitat Units — Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project) PLANS 3 AND 4
Life of Project: 100
Evaluation Species: 1 BARRED OWL — AAHU's: 68017.96

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	188955.00	0.36	68023.80
1	188955.00	0.36	68023.80
8	188938.00	0.36	68017.68
25	188938.00	0.36	68017.68
50	188938.00	0.36	68017.68
100	188938.00	0.36	68017.68

Form C: Average Annual Habitat Units — Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project) PLANS 3 AND 4
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL — AAHU's: 24562.04

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	188955.00	0.13	24564.15
1	188955.00	0.13	24564.15
8	188938.00	0.13	24561.94
25	188938.00	0.13	24561.94
50	188938.00	0.13	24561.94
100	188938.00	0.13	24561.94

Form C: Average Annual Habitat Units — Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project) PLANS 3 AND 4
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE — AAHU's: 90690.61

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	188955.00	0.48	90698.40
1	188955.00	0.48	90698.40
8	188938.00	0.48	90690.24
25	188938.00	0.48	90690.24

50	188938.00	0.48	90690.24
100	188938.00	0.48	90690.24

Form D: Net Change in AAHU's   Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project)   PLANS 3 AND 4
Compared To: PA 1 (without project)   PLANS 3AND 4
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	BARRED OWL	68017.96	68023.80	-5.84
2	FOX SQUIRREL	24562.04	24564.15	-2.11
3	CAROLINA CHICKADEE	90690.61	90698.40	-7.79

Form C: Average Annual Habitat Units Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 1 (without project) PLAN 3 AND 4 MINK
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 127.30

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	190.00	0.67	127.30
1	190.00	0.67	127.30
2	190.00	0.67	127.30
8	190.00	0.67	127.30
25	190.00	0.67	127.30
50	190.00	0.67	127.30
100	190.00	0.67	127.30

Form C: Average Annual Habitat Units Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project) PLANS 3 AND 4 MINK
Life of Project: 100
Evaluation Species: 1 MINK AAHU's: 139.78

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	190.00	0.67	127.30
1	181.00	0.67	121.27
2	209.00	0.67	140.03
8	209.00	0.67	140.03
25	209.00	0.67	140.03
50	209.00	0.67	140.03
100	209.00	0.67	140.03

Form D: Net Change in AAHU's

Date: 01/03/1998

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 2 (with project) PLANS 3 AND 4 MINK
Compared To: PA 1 (without project) PLAN 3 AND 4 MINK
Life of Project: 100

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	MINK	139.78	127.30	12.48

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 1 BARRED OWL AAHU's: 259036.39

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.54	259036.39
1	479697.00	0.54	259036.39
23	479697.00	0.54	259036.39
100	479697.00	0.54	259036.39

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 2 FOX SQUIRREL AAHU's: 249442.43

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.52	249442.43
1	479697.00	0.52	249442.43
23	479697.00	0.52	249442.43
100	479697.00	0.52	249442.43

Form C: Average Annual Habitat Units Date: 10/18/1997

Study Name: MISSISSIPPI RIVER LEVEES
Action: PA 9 (without project) PLAN 3
Life of Project: 100
Evaluation Species: 3 CAROLINA CHICKADEE AAHU's: 307006.07

Target Year	Area of Habitat	Habitat Suitability Index	Habitat Units
0	479697.00	0.64	307006.07
1	479697.00	0.64	307006.07
23	479697.00	0.64	307006.07
100	479697.00	0.64	307006.07

APPENDIX 11
ENDANGERED SPECIES
BIOLOGICAL ASSESSMENT

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 11
ENDANGERED SPECIES
BIOLOGICAL ASSESSMENT

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2	LETTER, U.S. FISH AND WILDLIFE SERVICE, AUGUST 28, 1997
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4	PALLID STURGEON RECORDS FOR STUDY AREA

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
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APPENDIX 11
ENDANGERED SPECIES
BIOLOGICAL ASSESSMENT

INTRODUCTION

1. This Biological Assessment (BA) evaluates the potential effects of proposed Mississippi River Mainline levee enlargement and seepage control on the pallid sturgeon (Scaphirynchus albus), fat pocketbook pearly mussel (Potamilus capax), interior least tern (Sterna antillarum), bald eagle (Haliaeetus leucocephalus), and wood stork (Mycteria americana). Pertinent biological and ecological data for the endangered species are based on both published and unpublished literature, communication with experts, and findings of recent U.S. Army Corps of Engineers investigations.

2. A portion of the proposed project is within the historic range of the threatened Louisiana black bear (Ursus americanus luteolus). The U.S. Army Corps of Engineers, Vicksburg District (CEMVK) prepared a generic BA (January 1996) for the Louisiana black bear. The BA concluded that, with conservation measures included, the proposed project would have no adverse effect on the bear. The U.S. Fish and Wildlife Service (FWS) concurred with the "no effect" conclusion (Attachments 1 and 2). The Louisiana black bear BA is attached (Attachment 3).

3. The proposed project construction is part of the Mississippi River and Tributaries (MR&T) Project authorized by the Flood Control Act of 1928.

4. This BA was submitted to FWS pursuant to Section 7 of the Endangered Species Act, as amended.

PROJECT DESCRIPTION

5. The proposed project extends from the Head of Passes on the lower extremity of the Mississippi River to Cape Girardeau, Missouri (Figure 11-1). Specific items of work (including FY 98 Items 496-L and 489-R), consisting of Mississippi River mainline levee enlargement and seepage berm and/or relief well construction, would be accomplished within the Mississippi River batture lands and/or within 3,000 feet landward of the levees. To the maximum extent practical, the project's design relocates borrow area sites from wooded wetlands to cleared lands in order to minimize adverse impacts on wetlands and bottom-land hardwoods.

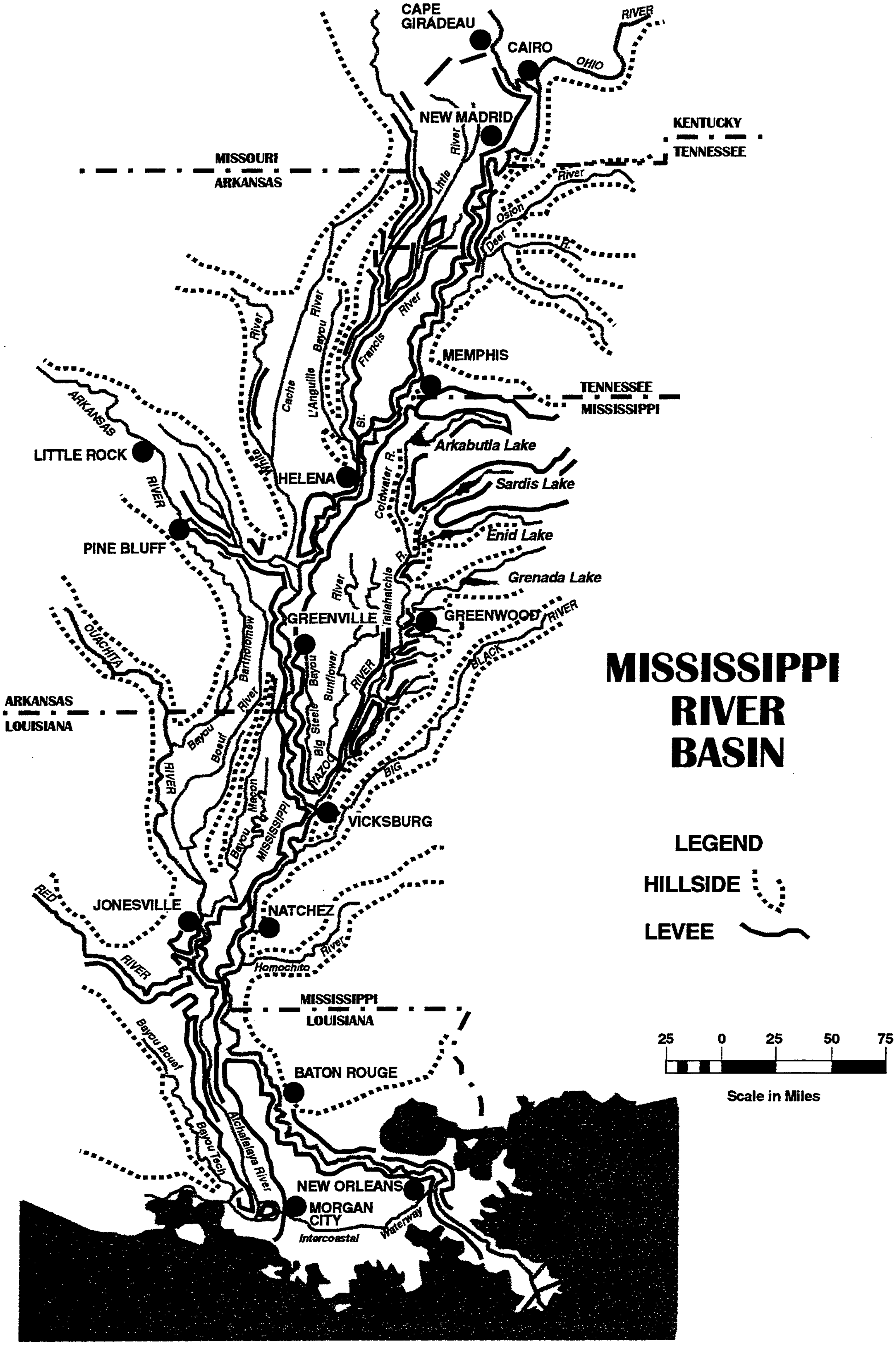

Figure II-1. Mississippi River Basin levee system

ENDANGERED SPECIES ASSESSMENT

PALLID STURGEON

Description

6. The pallid sturgeon was listed Federally as an endangered species on 6 September 1990 (Federal Register 55: 36647; FWS, 1994), and a recovery plan was approved 7 November 1993 (Dryer and Sandvol, 1993). Prior to this, it was listed as a threatened or endangered species by 9 of the 13 states in which it occurs or occurred (Kallemeyn, 1983). It was also listed as threatened, later endangered, throughout its range, by the Endangered Species Committee of the American Fisheries Society (Deacon, et al., 1979; Williams, et al., 1989). Imperilment of this species is attributed to "destruction, modification, or curtailment of its habitat or range" and "other natural or manmade phenomena" (Williams, et al., 1989).

7. The pallid sturgeon is one of only three species of river sturgeons (Scaphirhynchus spp.), an ancient group of fishes, which inhabit large, turbid rivers of the central United States. The recently described Alabama sturgeon (Scaphirhynchus suttkusi) is endemic to the Mobile Basin (Mayden and Kahajda, 1995). The pallid sturgeon occurs sympatrically with the shovelnose sturgeon (Scaphirhynchus platorynchus) in parts of the Mississippi-Missouri River Basin (Lee, 1978a,b). The shovelnose sturgeon, however, occurs over a wider geographic range than the pallid sturgeon, inhabiting the upper Mississippi River and formerly inhabiting the Rio Grande Basin from which the pallid sturgeon is unknown.

Taxonomic Status

8. Fishes characteristic of swift, turbid rivers with high temporal variation in discharge share several morphological features (Cross and Moss, 1987). They are ventrally flattened and possess small eyes, hyper-developed cutaneous sense organs, and crowded, embedded scales. Sturgeon, however, are exceptional. They are large, elongate fishes with a pronounced rostrum (hard, forward-projecting snout), five rows of boney plates (one dorsal, two lateral, and two ventrolateral), a muscular extension of the body into the upper lobe of the tail fin, and an inferior protrusible mouth immediately posterior to four fleshy barbels (Robison and Buchanan, 1988). River sturgeon differ from other sturgeons by lacking spiracles (small openings into the gill chamber, anterior to the operculum) and by possessing a long filament on the upper lobe of the tail fin and a flat, spadelike rostrum. Both structures have hydrodynamic functions. The caudal filament probably provides sensory input allowing young sturgeon to stay aligned in current and avoid displacement by high velocities (Weisel, 1978). The rostrum generates "lift" during swimming and "resistance" during station-holding (Aleev, 1963).

9. The three species of river sturgeons are very similar in appearance and early biologists did not distinguish them from each other. Unusually pale river sturgeons were observed by commercial fisherman, and in 1905, these were recognized as a distinctive form (Forbes and Richardson, 1905). Originally described as a new species belonging to a new genus (Parascaphirhynchus albus), the pallid sturgeon was later reevaluated taxonomically based on larger numbers of specimens and reassigned to same genus as the shovelnose sturgeon (Bailey and Cross, 1954).

10. Pallid sturgeon differ from shovelnose sturgeon by their conspicuously lighter coloration and in several morphomeristic characters (Bailey and Cross, 1954; Robison and Buchanan, 1988; Keenlyne, et al., 1994; Mayden and Kahajda, 1996). Pallid sturgeon have a greater number of rays in the dorsal fin (37-42 versus 30-36) and anal fin (24-28 versus 18-23). Scales on the belly are absent or reduced compared with those of shovelnose sturgeon. In pallid sturgeon, the bases of the barbels are arranged in an arc and the outer barbels are substantially (1.72-3.54 times) longer than the inner barbels. In shovelnose sturgeon, the bases of the barbels are aligned and the outer barbels are only slightly (1.05-1.78 times) longer than the inner barbel.

11. Although pallid and shovelnose sturgeons are "readily separable . . . well-marked species" (Bailey and Cross, 1954) and are readily distinguished by field ichthyologists, they are genetically (electrophoretically) indistinguishable (Phelps and Allendorf, 1983). This apparent incongruity is attributed to incomplete reproductive isolation of the two species and rapid morphological differentiation.

<u>Range and Population Level</u>

12. Pallid sturgeon are found throughout the Missouri River, the middle and lower Mississippi River, and in several of larger tributaries including the Yellowstone, Platte, Kansas, St. Francis, Yazoo, Big Sunflower, and Atchafalaya Rivers (Lee, et al., 1980a; Kallemeyn, 1983; Ross and Brenneman, 1991). However, in Mississippi, there are only two museum records of pallid sturgeon--one for the Mississippi River and one for the lower Big Sunflower River (S. Ross, personal communication; S. Krentz, personal communication). A preserved museum specimen exists for the Mississippi River. No specimen, however, exists for the Big Sunflower River record (C. Knight, personal communication). That sturgeon was caught in 1987 by a local fisherman and brought to the Mississippi Museum of Natural Science where it was maintained alive in an aquarium. It subsequently died and was preserved. The specimen was lost prior to being assigned a catalog number. It is unknown whether the specimen was ever examined by a biologist familiar with sturgeon taxonomy, and the possibility of a misidentified shovelnose sturgeon cannot be discounted. Pallid sturgeon are more frequently encountered in the Missouri and Atchafalaya Rivers than in the Mississippi River (Carlander, 1969; Dryer and Sandvol, 1993; Etnier and Starnes, 1993; Constant, et al., 1997), but are "nowhere common" (Bailey and Cross, 1954; Kallemeyn, 1983).

13. Rarity of the pallid sturgeon is indicated by the paucity of records in the early scientific literature. The original taxonomic description was based on nine specimens collected near the mouth of the Illinois River (Forbes and Richardson, 1905). In the next half-century, it was "definitively reported" only from the mouth of the Missouri River and the Mississippi River at Keokuk, Iowa. Redescription of the species was based on 17 specimens from 8 localities (Bailey and Cross, 1954). Occurrences in regional fish references are typically based on anecdote (Harland and Speaker, 1951), sporadic occurrence (Cross and Collins, 1975), or fewer than 5 voucher specimens (Cook, 1959; Douglas, 1974; Robison and Buchanan, 1988; Ross and Brenneman, 1991; Etnier and Starnes, 1993).

14. Records compiled for a 70-year period total only 250 observations (Kallemeyn, 1983). Approximately 76 percent are from the Missouri River in Montana and the Dakotas, and most of those are from reservoirs constructed during the 1950's and 1960's. Only 13 specimens were confirmed from the lower Mississippi River prior to 1983. Since then, a large population has been documented in the Atchafalaya River. Over 100 specimens were observed during a 2-year study (Constant, et al., 1997).

Habitat and Reasons for Decline

15. Pallid sturgeon, like shovelnose sturgeon, inhabit comparatively large flowing rivers, but pallid sturgeon occur over a narrower range of conditions. They prefer greater turbidity (Bailey and Cross, 1954; Lee, 1980a; 1980b), finer substrates, and deeper, wider channels. They are more likely than shovelnose sturgeon to occur in sinuous reaches and near long-established islands and alluvial bars (Bramblett, 1996). Pallid sturgeon typically inhabit thalwegs and channels of relatively low slope (Constant, et al., 1997). Characteristic depths inhabited by pallid sturgeon vary among populations and with river morphometry, but fish typically avoid shallow waters. In the Atchafalaya River, pallid sturgeon inhabited depths of 7 to 21 meters (Constant, et al., 1997).

16. Rarity of the pallid sturgeon makes it difficult to document habitat-related declines in populations, but declining populations and range reductions of paddlefish and shovelnose sturgeon suggest that populations of pallid sturgeon are similarly impacted (Kallemeyn, 1983). Reduced numbers and possible extirpations are indicated in Kansas and in Missouri and are attributed to anthropogenic regulation of river flows (Cross and Moss, 1987; Pflieger and Grace, 1987). Dams block movements of pallid sturgeon, which may have home ranges greater than 300 kilometers, and populations become segregated and fragmented (Keenlyne, et al., 1994; Bramblett, 1996). Impoundments also create lentic environments which are avoided by pallid sturgeon (Constant, et al., 1997). Impoundments also reduce discharge, variation in discharge, erosion, turbidity, and presence of fine substrates, habitat factors to which the pallid sturgeon is specifically adapted (Bailey and Cross, 1954; Cross and Moss, 1987).

17. Reduced turbidity of water and prevalence of coarse substrates are believed to reduce feeding efficiency of the pallid sturgeon, a turbid water piscivore, and enhance feeding by shovelnose, a clearer water invertivore. Population declines may be attributed to lowland rivers that have become more like upland habitats, favoring shovelnose sturgeon, and possible competition with the more adaptable, but biologically similar species (Pflieger and Grace, 1987; Ruelle and Keenlyne, 1994). Length-weight relationships for pallid sturgeon in the upper Missouri River suggest that fish of a given size were heavier prior to completion of reservoirs than after the reservoirs were established (Keenlyne and Maxwell, 1993).

18. Water pollution may also have impacted pallid sturgeon populations. Long-lived, bottom-feeding fishes can bioaccumulate heavy metals and organic pesticides in their tissues. In the Missouri River, pallid sturgeon with high concentrations of mercury, cadmium, selenium, PCB's, DDT's, chlordane, and dieldrin are documented (Ruelle and Keenlyne, 1993). These substances accumulate in multiple organ systems including the kidney, liver, and ovaries. High concentrations are associated with lower growth rates and decreased standing crops of fish. Several of these contaminants are concentrated in egg tissues and probably impair successful reproduction.

19. Altered habitats reduce isolating mechanisms of sympatric species, and abundances of the two sturgeon species are disparate. Both factors reduce likelihood of intraspecific matings of pallid sturgeon and increase the likelihood of interspecific hybridization. Although some estimates of relative abundance of pallid to shovelnose sturgeon are as high as 1: 5 (Etnier and Starnes, 1993), most estimates are much lower, 1:20 to 1:400 (Kallemeyn, 1983; Carlson, et al., 1985). Collections of more than 300 sturgeon in the lower Mississippi River suggest a ratio of approximately 1 pallid for every 30 shovelnose sturgeon (Hoover and Killgore, unpublished data).

20. Hybridization between shovelnose and pallid sturgeon has not been extensively documented and is believed to be a recent phenomenon (Carlson, et al., 1985). Values for morphological and meristic characters of hybrids are intermediate between those of shovelnose and pallid sturgeon. Hybrids also demonstrate intermediate growth rates and levels of piscivory when compared with those of the parent species. Initially, documented percentage of hybrids was low (less than 0.5 percent of sturgeon), but more recent estimates have indicated high percentages in the middle Mississippi River (86.4 percent) and in the Atchafalaya River (43.8 percent) (Keenlyne, et al., 1994b). These hybrids are not intermediate in all morphomeristic characters suggesting that they are not F1 hybrids (first generation offspring of two different species).

21. Pallid sturgeon may also be impacted by commercial fishing. Historically, river sturgeon were occasionally targeted by commercial fishermen and were frequently obtained as bycatch. Large specimens, including pallid sturgeon, were exploited for caviar, and smaller specimens, including shovelnose sturgeon, were discarded as nuisances (Carlander, 1954; Moos, 1978). Commercial fishing is believed to have contributed to declines of both species since the early 20th century (Keenlyne, 1989). Consequently, several states now prohibit fishing for and retention of any river sturgeon.

Life History

22. Little life history information is available for pallid sturgeon (Bailey and Cross, 1954; Carlander, 1969; Kallemeyn, 1983). Available data are typically based on small numbers of observations from a few localities. Juveniles and small adults are not well-represented in museum collections (B. Kahajda, personal communication) or in contemporary studies of ecology, movement, etc. (e.g., Carlander, 1969; Carlson, et al., 1985; Keenlyne, et al, 1992; Keenlyne, et al., 1994, Bramblett, 1996; Liebelt, 1996; Constant, et al., 1997). Information on age and growth is based principally on observations of adults and back calculations of sizes at different ages indicated by growth rings in the pectoral rays (Kallemeyn, 1983).

23. Pallid sturgeon are large, long-lived, and slow to mature. They attain sizes of 167 centimeters (cm) total length (TL) and 31 kilograms, although adult sizes of 53 to 88 cm TL are probably typical (Carlander, 1969; Lee, 1980a; Kallemeyn, 1983). The age of one individual 140 cm TL (approximately 151 cm TL) and 17 kilograms was estimated at 41 years. Pallid sturgeon probably attain greater ages than this (Keenlyne, et al., 1992). Age of sexual maturity is 5 to 7 years for males and 9 to 12 years for females, but first spawning may not begin until age 15 to 17 years or later (Keenlyne and Jenkins, 1993). Sex ratios may be skewed. Females outnumbered males 2:1 throughout the Missouri and Mississippi Rivers (Carlson, et al., 1985),

but 13 specimens collected in the middle Mississippi River consisted of 12 males and 1 undetermined individual (R. Sheehan, personal communication). Fecundity, however, is high. One very large female contained 170, 000 eggs, approximately 11 percent of her body weight (Keenlyne, et al., 1992).

24. Spawning has never been observed (Kallemeyn, 1983). Larvae, distinctive and distinguishable from shovelnose sturgeon (Snyder, 1994), have not been collected in the field. Based on apparent reproductive conditions of adults, the spawning season is believed to be during spring, initiation dependent upon latitude and timing of proximate cues like spring runoff. It is presumed to take place during high water. Spawning probably begins in March in the lower Mississippi and Atchafalaya Rivers, late April or early May in the lower Missouri and middle Mississippi Rivers, and late May or early June in the upper Missouri River (Keenlyne and Jenkins, 1993).

25. Growth during the first year is rapid. At age 1, pallid sturgeon are approximately 28 cm TL and weigh 30 grams (g). They grow an additional 10 cm per year during the following 3 years, and 3 to 6 cm per year after age 5 (Kallemeyn, 1983). From approximately age 2 to 6, weight increases 60 to 250 g per year; in larger (>670 millimeters TL), older fish, weight increases more than 350 g per year (Keenlyne and Maxwell, 1993).

26. Pallid sturgeon, like shovelnose sturgeon, feed on aquatic insects, but unlike shovelnose sturgeon, also consume fish (Carlson, et al., 1985). Dominant prey (greater than 35 percent total food volume) are caddis worms (Trichoptera) and fishes. Other insects are eaten frequently, but comprise smaller portions of the diet (less than 10 percent total food volume). These include naiads of mayflies (Ephemeroptera), dragonflies and damselflies (Odonata), and larvae of true flies (Diptera). Plant material is also frequently ingested but in small quantities. Captive specimens can be maintained on a steady diet of fish (Bramblett, 1996).

Additional Data

27. General and project-specific permits issued by the Corps recognize potential dredging-related risks to spawning pallid sturgeon. Dredging is prohibited during presumed "windows" of pallid sturgeon reproduction, 1 April through 30 June in New Orleans and Vicksburg Districts and 12 April through 30 June in the Memphis District.

28. Records of pallid sturgeon for the five-state study area are provided (Attachment 4). Few specimens are known prior to 1945, and the majority of records through 1995 (65 percent) are from a single location in the Atchafalaya River. Paucity of pallid sturgeon records from major portions of its geographic range, particularly the Mississippi River, indicates the difficulty with which specimens are obtained. Because they inhabit deep, fast-flowing, mid-channel waters, and because specialized collecting techniques must be implemented to capture them, few pallid sturgeon are seen by ichthyologists and fisheries biologists.

29. River sturgeon have been sampled by U.S. Army Engineer Waterways Experiment Station in the lower Mississippi River near the confluence of the Arkansas River (Hoover and Killgore, unpublished data). In 1995 and 1996, approximately 200 sturgeon were collected. Most were tagged with passive integrated transponder tags and Peterson discs and released; others were retained for a morphological study of shovelnose sturgeon. A few specimens (less than 10) were pallid sturgeon or hybrids. During January and February 1997, 127 sturgeon collected for a study of morphological differences between pallid and shovelnose sturgeon also provided data on

relative abundance and habitats of the two species (Figure 11-2). Pallid sturgeon numbered 4, shovelnose 123, with no obvious hybrids. Shallow (less than 15 feet deep), near-shore (less than 100 feet from water's edge) habitat was not sampled, but pallid sturgeon occupied a narrower range of conditions than did shovelnose sturgeon. Three of the four pallid sturgeon were collected more than 250 feet from shore and all were collected in depths greater than 35 feet. Observations support previous studies demonstrating that pallid sturgeon occupy midchannels and deeper water more frequently than do shovelnose sturgeon, which are more likely to occur in shallower, near-shore waters (Moos, 1978; Bramblett, 1996; Constant, et al., 1997).

Evaluation of Potential Impact

30. Project-related impacts to the pallid sturgeon are not foreseen. Pallid sturgeon avoid shall water and typically inhabit thalwegs with hard-packed, sandy substrate, and channels of relatively low slope. These habitats do not coincide with river locations that would be impacted by construction. Dredging will take place during low water at some work item locations to obtain material for berm construction, outside the pallid sturgeon spawning "window " (Keenlyne and Jenkins, 1993). Adult pallid sturgeon are not believed to be impacted by dredging (Constant, et al., 1997). Dredges proposed for this project consist of 35-foot and 120-foot pipes (CEMVK, personal communication). Sediment removed from near-shore areas or shallower waters offshore are unlikely to affect pallid sturgeon inhabiting deep water in the main channel (Figure 11-2).

FAT POCKETBOOK PEARLY MUSSEL

Description

31. FWS listed the fat pocketbook pearly mussel (Potamilus (=Proptera) capax) as an endangered species on 24 June 1976 (Federal Register 41:26019). The recovery plan for the species was approved 4 October 1985. The fat pocketbook pearly mussel superficially resembles the more widespread Lampsilis ovata, with which it is occasionally confused. It is distinguished from L. ovata by its shiny yellow to brown epidermis and absence of rays. The anterior end is sharply rounded and slightly angular near the hinge, and the posterior end is broadly rounded. The strong S-curve of the hinge line and the absence of pronounced sexual dimorphism in shell characters further distinguishes this species. The shell is stout, but thin; size is to 9.3 cm; and inflated with the posterior ridge sharply angled. Beaks are broad, high, and decidedly turned inward. The beak cavities are deep and wide with nacre bluish-white tinged with salmon and often iridescent posteriorly.

Taxonomic Status

32. The fat pocketbook was described by Green in 1832 as Unio capax. The same year, it was described by Lea as Symphynota globosa. Since Green's description preceded that of Lea by several months, the name capax is accepted for this species. It was subsequently placed in the genus Lampsilis by Smith (1899) and moved to the genus Proptera by Ortmann (1914) where it has remained.

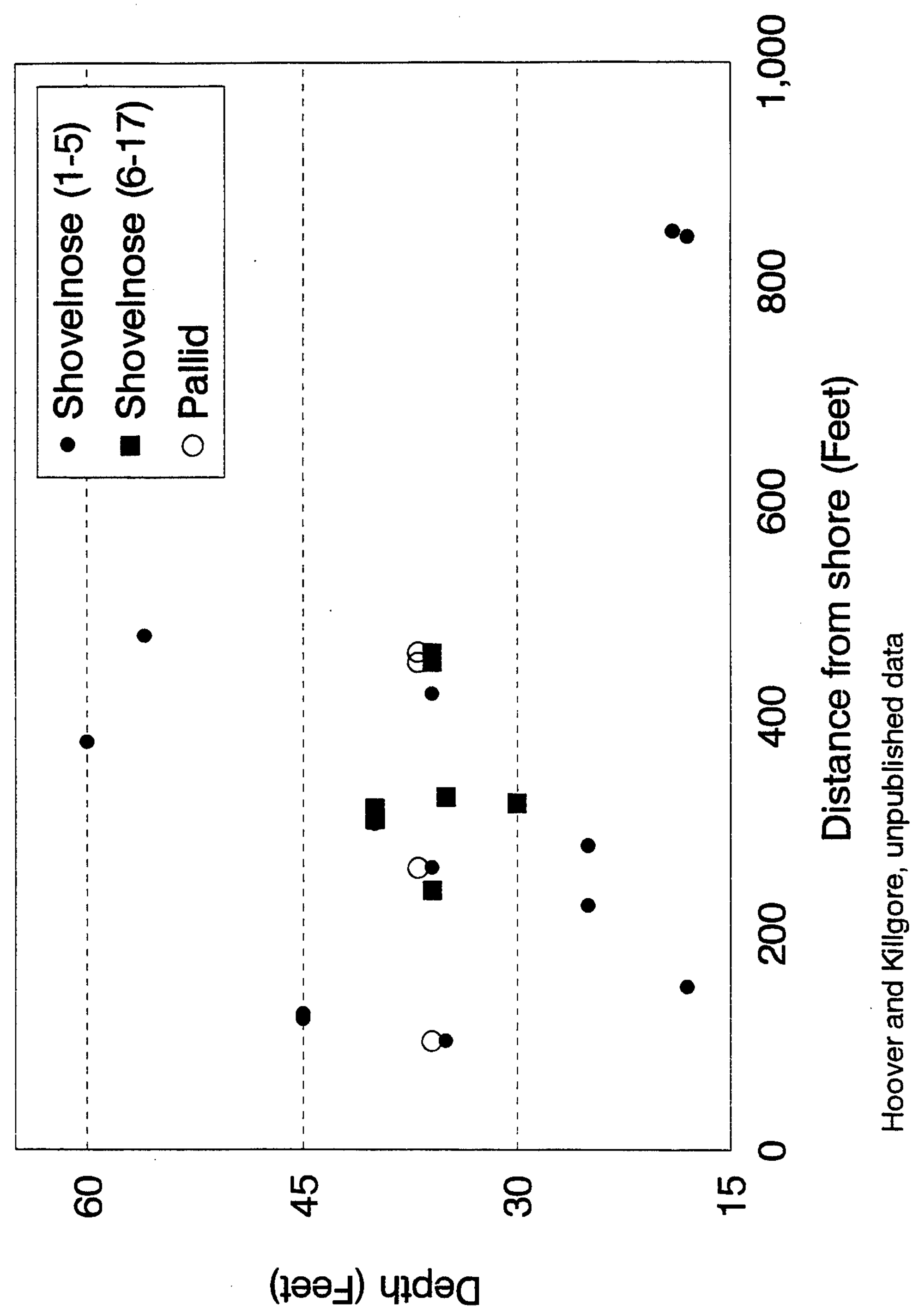

Figure 11-2. River sturgeon collected in the lower Mississippi River near the confluence of the White River during 1995 and 1996.

Geographic Range and Distribution

33. There are few published distribution records for the fat pocketbook pearly mussel. Most historic information (prior to 1970) is based on museum collections. The museum records appear to be from three areas--the upper Mississippi River (above St. Louis, Missouri); the Wabash River, Indiana and Illinois; and the St. Francis River, Arkansas. Recent records are generally for the St. Francis River. Approximately 2,300 fat pocketbooks from the St. Francis River population have been transplanted to two sites on the upper Mississippi River by the Missouri Department of Conservation. The two sites of the 1988 capax transplant effort in the upper Mississippi River were between river mile (RM) 291 and 293 (Blackbird Island) in Pike County, Missouri, and between RM 355 and 357 (Fox Island) in Clark County, Missouri. The transplanted populations are the focus of continued monitoring by the resource management agencies (Koch, 1990).

Habitat and Reason for Decline

34. Museum records indicate that the fat pocketbook pearly mussel is a large river species which requires flowing water and stable substrate. Parmalee (1967) reported the fat pocketbook pearly mussel from sand and mud bottoms in flowing water a few inches to more than 8 feet in depths. Bates and Dennis (1983) found the species in sand, mud, and fine gravel substrates in the St. Francis River, Arkansas. Clarke (1984) reported the species primarily from sand substrates in the St. Francis River. The life cycle for the fat pocketbook pearly mussel including the fish host is unknown. Historic habitat has been altered by channel modification, impoundment, pollution, and dredging.

Evaluation of Potential Impact

35. The proposed action will not require any work within habitat suitable for the fat pocketbook pearly mussel. Therefore, the fat pocketbook pearly mussel will not be impacted by the proposed construction.

INTERIOR LEAST TERN

Description

36. The interior least tern, Sterna antillarum athalassos, was listed as a Federally endangered species on 27 June 1985 (Federal Register 50(102):21784-21792). The recovery plan for the species was approved on 19 September 1990. Least terns are the smallest of the American terns, measuring from 21.6 to 24 cm long and having a wingspan of approximately 51 cm. The three United States subspecies are virtually indistinguishable morphologically and are presently distinguished by the separation of their breeding ranges. Least terns have a black-capped crown, white forehead, a black-tipped yellow bill, gray back and dorsal wings, white belly, and orange legs. The sexes are virtually identical. Juveniles tend to have a darker, mottled, brownish plumage and bill compared to adults, with a dark band behind the eye and dark shoulder patch.

Taxonomic Status

37. The least tern species (Sterna antillarum) was first described by Lesson in 1847. During the 1940's, this bird was classified as a subspecies of the European little tern (Sterna albifrons) (Burleigh and Lowery, 1942). As a result of more recent studies on vocalizations, behavior, and limited morphology, Old and New World least/little terns are now considered separate species. The species name has been returned to Sterna antillarum. Due to taxonomic difficulties, FWS is uncertain if the interior least tern qualifies as a separate subspecies. However, the Endangered Species Act allows for the listing of vertebrate subspecies as a discrete population.

Range and Population Level

38. The interior least tern is a migratory shore bird that breeds and rears its young on islands along the Mississippi, Missouri, Arkansas, and Ohio Rivers system. Interior least terns arrive at nesting areas from late April through early June and spend approximately 4 to 5 months at breeding sites. Fall departure from colony sites varies according to the season, area, and time of nesting, but generally no later than early September. Least terns of the lower Mississippi River Valley migrate through and winter along the northern and eastern coasts of South America, the eastern and western coasts of Central America, and the Caribbean Islands, mixing with other least tern subspecies of North America. Exact wintering locations are largely undocumented (Whitman, 1988). At the time of the Federal listing in 1985, approximately 1,400 to 1,800 terns were believed remaining in the total United States population (FWS, 1985). Past census surveys concentrated on where terns had been found historically and did not seek possible new locations. The only real census over the entire lower Mississippi River was limited by time, money, and equipment (Hardy, 1957). Recent, more comprehensive surveys indicate the terns move in response to habitat changes. The Corps and many state agencies have attempted to standardize survey techniques and data recording methods. These coordinated surveys have revealed much larger population numbers, especially in the lower Mississippi River.

Habitat and Reason for Decline

39. Interior lest terns on the lower Mississippi River choose nest colony sites on large, isolated sandbars or on the upstream and high downstream sandy points of islands. Almost all colony sites are on land which is separated from the riverbank during the breeding season. Terns do not use grassland or woodland habitat. Any trees which are present on the otherwise bare sandbars are located several hundred yards away from the colony. The specific colony site is almost always on the highest part of the sandbar, the first part to become exposed as high spring river water stages recede. Nest sites are well-drained and well back from the water line. Individual nests are shallow depressions scraped out in the bare sand, usually next to a small piece of driftwood, among the debris wrack lines, or within short sparsely scattered vegetation. On sandbars without driftwood, nests are in bare sand and usually placed on the sand ripple edges (Rumancik, 1986 to 1995; Renken and Smith, 1995; Smith and Renken, 1991 and 1993). Migration habitat characteristics have not been studied in any detail as they have not been described in literature. However, it appears likely that least terns use similar types of habitat as are used for nesting, resting, and foraging during the regular breeding season.

40. Interior least terns are opportunistic feeders, taking any fish which is about 2.5 inches long. They feed primarily on threadfin shad, the predominant small fish of the Mississippi River. Other forage species in the lower Mississippi River include white bass, largemouth bass, silverside, topminnow, buffalo, drum, and bluegill. Foraging habitat in the Mississippi River primarily includes water at the riverside shore of the resting colony, along revetted riverbank, and midriver channel. Lesser sites are at the mouths of tributary streams, turbulent water around dikes, backwater chutes, and occasionally ponds and lakes near the river (Rumancik, 1986 to 1995).

41. As indicated, interior least terns are colonial birds which nest on bare alluvial islands or sandbars. The primary reasons cited in the literature for the decline in population throughout the country are attributed to the channelization and damming of rivers and the subsequent loss of sandbar and shallow water habitat within the interior least tern's historic breeding range. In addition, increasing river development for industrial and recreational uses and increased irrigation water withdrawal from some rivers in the upper Midwest have also caused a decline in available habitat in those places. However, in the lower Mississippi River Valley, habitat conditions are still in a relatively natural condition with the 40-foot difference between high and low river stages maintaining the many sandbars used by least terns. Ample habitat still exists for the interior least tern and its forage fish. A recent study by Cobb (1997) indicates that the sandbars created among the dikes have increased least tern nesting habitat. Little is known about the interior lest tern on its winter range. Significant problems occurring there could be affecting the population decline. This will require further study.

Additional Data

42. On the lower Mississippi River, the interior least tern population is generally concentrated along the northern 600 miles of the river from between Natchez, Mississippi, and the confluence of the Mississippi and Ohio Rivers at Cairo, Illinois. In boat and aerial surveys conducted by the Corps from 1986 to 1995, the number of least terns observed along the respective reach ranged from 1,300 the first year to more than 5,900. Least terns were found at 37 to 72 sandbar sites along the river (Rumancik, 1986 to 1995). Upon review of the Recovery Plan and other available breeding season data for the interior least tern, it is apparent that the Mississippi River contains the largest remaining population of least terns. Over half of the total United States interior least tern population occurs between Cairo, Illinois, and Natchez, Mississippi (Cobb, 1997; Sidle and Harrison, 1990; Rumancik, 1986 to 1995).

43. Interior least terns are not disturbed by towboats or small recreational pleasure boats passing the nesting colonies. Fishermen in boats out from the shore are also not perceived as a threat by the terns. Recreation on the sandbars is minimal and generally confined to the weekend and on sandbars near large cities. This infrequent recreation poses little threat to least tern nesting colonies as the human activity occurs along the water line, far from the nest sites several hundred yards higher up on the bar (Rumancik, 1986 to 1995).

Evaluation of Potential Impacts

44. The interior least tern is a colonial nesting bird that requires large, isolated, bare sandbars in large rivers for nesting habitat. All potential borrow within Memphis and New Orleans Districts will be obtained from sites which are away from the Mississippi River. No borrow material will be dredged from any sandbars or open river within the New Orleans and Memphis Districts. Thus, least tern habitat will not be impacted within these two Districts.

45. Within the Vicksburg District, sand borrow material is currently proposed to be dredged from four open water sites and one sandbar in the Mississippi River. The sites are presented in Table 11-1.

TABLE 11-1
SAND BORROW MATERIAL DREDGE SITES

River Mile	Open Water Acres	Sand Acres	Terns
486-L	161		
490-L	125	13	
493-L a/	103		
498-L a/	334		

a/ Items 493-L and 498-L have been combined with Items 495-L and 497-L and renamed 496-L.

46. All lower Mississippi River least tern surveys conducted by the Corps were researched for locations of nesting colonies or resting sandbars. No open water dredging sites are located near interior least tern nesting and foraging sites (Cobb, 1997; Rumancik, 1986 to 1995).

47. One sandbar located at RM 490-L is proposed to be used for borrow. This sandbar has never been used by least terns, and its configuration is such that it is highly unlikely it will ever be used as a least tern nesting site. Thus, no adverse impacts are expected if this sandbar is used for borrow material. Prior to commencing dredging activities at any of the sites in question, the appropriate Corps District Regulatory Branch will be consulted for the latest interior nesting information. Dredging will not be conducted anytime of the year within 200 feet of the shoreline or sandbars on which interior least tern nesting colonies have been recorded.

48. The proposed project will not adversely impact the interior least tern population on the Mississippi River.

BALD EAGLE

Description

49. FWS reclassified the bald eagle (Haliaeetus leucocephalus) from endangered to threatened throughout the 48 conterminous states on 12 July 1995. Previously, the bald eagle had been listed as endangered in all states except Washington, Oregon, Minnesota, Wisconsin, and Michigan. The bald eagle is a large raptor, having a wingspan of about 7 feet. Its plumage is mainly dark brown, and adults have a pure white head and tail. First-year juveniles are often chocolate brown to blackish, sometimes with white mottling on the tail, belly, and underwings. The head and tail become increasingly white with age until full adult plumage is reached in the fifth or sixth year. An opportunistic predator, the bald eagle feeds primarily on fish, but also takes a variety of birds, mammals, and turtles (both live and as carrion) when fish are not readily available.

Taxonomic Status

50. Historically two species of bald eagle were recognized, the southern bald eagle, Haliaeetus leucocephalus leucocephalus, and the northern bald eagle, Haliaeetus leucocephalus alascanus. These two subspecies names were in use when the southern bald eagle was listed 11 March 1967, as endangered under the Endangered Species Protection Act of 1966. By the time the bald eagle was listed as endangered for the entire lower 48 states, the subspecies was no longer recognized by ornithologists.

Range and Population Level

51. With the exception of extreme northern Alaska and Canada and central and southern Mexico, the bald eagle historically ranged throughout North America. The breeding season of bald eagles varies with latitude. However, the general tendency is for winter breeding in the South with a progressive shift toward spring breeding in northern locations. In the Southeast, nesting activities generally begin in early September. Egg laying begins as early as October and peaks in late December. Two eggs are normal, but there are sometimes one or three. The eggs are dull white in color and are laid at intervals of several days. The incubation period is about 35 days, with both parents sharing. Renesting may occur if the eggs are lost early in incubation. Bald eagles mature slowly, requiring 4 or 5 years to gain adult plumage and reach breeding age.

52. In the 17 years since it was listed throughout the conterminous 48 states, the bald eagle has increased in number and expanded in range. In 1963, a National Audubon Society survey reported 417 active nests or eagle pairs in the lower 48 states. Productivity was 0.59 young per active nest. By 1974, the number of active nests had risen to 4,452 and productivity was estimated to be 1.17 young per active nest.

Habitat and Reason for Decline

53. The bald eagle is primarily riparian and usually nests near bodies of water where it feeds. Selection of nesting sites varies according to tree species in a particular area. Nests are usually constructed in living trees; however, bald eagles do occasionally use dead trees.

54. The major factor leading to the decline of the bald eagle was lowered reproductive success following the introduction of the pesticide DDT in 1947. DDT residues caused egg-shell thinning which led to broken eggs. The use of DDT was suspended in 1972, and by the late 1970's, eagle populations began to recover. Current factors affecting bald eagle recovery include habitat distraction, disturbance by humans, electrocution, illegal shooting, impact injuries, and lead poisoning. Bald eagle tolerance of disturbance is least during egg laying, incubation, and the first several weeks after hatching.

Evaluation of Potential Impacts

55. To ensure that the bald eagle is not adversely impacted, construction will not be conducted within 0.5 mile of any eagle nests during the time of egg laying, incubation, and the first month after hatching (1 October to 15 May). The "no-construction" period could be shortened for specific items of proposed construction if it is determined, in consultation with FWS biologists, that such construction would not adversely impact the bald eagle.

WOOD STORK

Description

56. FWS listed the United States breeding population of the wood stork (Mycteria americana) as Federally endangered on 28 February 1984 (Federal Register 49:7335). The recovery plan for the species' United States breeding population was approved 9 September 1986. Wood storks are large, long-legged wading birds, averaging 89 to 102 cm tall, with a wingspan of 152 to 165 cm. The plumage is white except for black primaries and secondaries and a short black tail. The head and neck are largely unfeathered and dark gray in color. The bill is black, thick at the base, and slightly decurved. Immature birds are dingy gray and have a yellowish bill.

Taxonomic Status

57. The wood stork is one of 17 species of true storks (Ciconiidae) occurring worldwide and is the only stork regularly occurring in the United States. The wood stork is also known as the wood ibis, ironhead, flint head, and gannet.

Range and Population Level

58. The wood stork may have formerly bred in all the coastal southeastern states from Texas to South Carolina. Currently, United States breeding is restricted primarily to Florida, but several rookeries are known to occur in coastal Georgia and one in South Carolina. Another distinct, nonendangered population breeds from Mexico to northern Argentina. A postbreeding dispersal brings birds (Mexican population) north up the Mississippi Valley. Most storks seen on the Texas and Louisiana coasts in the summer are probably from Mexico (Ogden, 1976). Occasionally, large numbers move northward beyond the usual summer range.

59. The current population of adult birds is difficult to estimate, since not all nest each year. Presently, the wood stork population in the United States is believed to number 11,000 adults. Mexican immigrants number approximately 1,000 to 5,000 birds, depending on the year.

Habitat and Reason for Decline

60. The United States breeding population of the wood stork occurs primarily in southeastern swamps and wetlands, usually nesting in cypress or mangrove swamps and feeding in freshwater or brackish wetlands. The wood stork is highly gregarious in both its feeding and nesting behavior. Borrow areas where fish become concentrated during periods of low water are particularly attractive feeding areas. The specialized feeding behavior of the wood stork involves tactolocation, also called grope feeding. Feeding usually takes place in water 15 to 50 cm (5.9 to 19.7 inches) deep. This primary feeding adaptation appears to be for predation on highly concentrated small fish. Particularly attractive feeding sites are depressions in marshes or swamps where fish become concentrated during periods of falling water levels.

61. The generally accepted explanation for the decline of the wood stork as a United States breeding species is the reduction in the food base necessary to support breeding colonies. This reduction is attributed to loss of wetland habitat as well as the changes in hydro periods. Loss of nesting habitat may also be affecting wood stork. Less significant factors known to affect nesting success include prolonged drought and flooding, raccoon predation on nests, and human disturbance of rookeries.

Evaluation of Potential Impacts

62. The primary limiting factors contributing to the wood stork's decline have been the loss of wetland habitat and changes in hydrology. The avoid-and-minimize environmental measures that are integral to the proposed project's design will significantly reduce the possibility of loss of acceptable habitat for the wood stork. The measures consist of avoiding, to the maximum extent practical, environmental damages to riverside woodlands and wetlands by relocating borrow areas from riverside forested wetlands to riverside prior converted farmlands or landside of the levee, utilization of existing berm material to raise and enlarge levees and replacement of the excavated material with dredged material from the Mississippi River, and constructing relief wells in lieu of berms to control seepage. The existing hydrology within the proposed project area will not be impacted by project construction. There is an unpublished record of breeding activity for wood stork in the project area. Six wood storks were observed in June 1997 attending nests at Jones Lake, Warren County, Mississippi (Mueller and McCabe, 1997). The nests were failures. The cause of the failures is unknown.

63. The proposed project will not adversely impact the wood stork.

CONCLUSION

64. Implementation of the proposed construction would not likely impact the pallid sturgeon, fat pocketbook pearly mussel, interior least tern, bald eagle, wood stork, and Louisiana black bear. This conclusion was reached after a review of appropriate literature and scientific data for each of the species in question and the inclusion, as appropriate, of specific conservation measures to ensure that the proposed construction would not adversely impact any of the species in question.

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1989 "Fishes of North America Endangered, Threatened, or of Special Concern: 1989." Fisheries 14:2-20.

ATTACHMENT 1
LETTER, U.S. FISH AND WILDLIFE SERVICE
NOVEMBER 30, 1995

United States Department of the Interior

FISH AND WILDLIFE SERVICE
2524 South Frontage Road, Suite B
Vicksburg, Mississippi 39180-5269

IN REPLY REFER TO:

November 30, 1995

Colonel Gary W. Wright
District Engineer
U.S. Army Corps of Engineers
2101 North Frontage Road
Vicksburg, Mississippi 39180-5191

Dear Colonel Wright:

The U.S. Fish and Wildlife Service (Service) has reviewed the Corps of Engineers Generic Biological Assessment (BA) dated November 1995 concerning possible effects of the Mississippi River mainline levee enlargement and berm construction work on the federally listed threatened Louisiana black bear (*Ursus americanus luteolus*). The following comments are provided in accordance with the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e) and the Endangered Species Act (87 Stat. 884, as amended U.S.C. 1531 et seq.).

The BA is well written and does a thorough job of evaluating possible adverse effects to the Louisiana black bear from the Mississippi mainline levee enlargement project. However, the Service would like to comment on one of the statements found in the BA. Paragraph 37 states that only .05 percent of the total bottomland hardwoods (out of 508,406 acres in the batture lands) would be affected. This may appear to be a small amount, but the total estimated direct impact of the MR&T Mainline Levee Project on forested wetlands within the delta region from 1937 to 1987 amounts to a loss of approximately 690,000 acres. Therefore, any further loss of forested wetlands within the project area should be considered significant considering the cumultive losses.

According to the BA, measures will be included in the project to minimize adverse impacts to the black bear. These measures include: leaving 50 yard wide forested travel corridors at each construction site; avoiding den trees (to the extent possible); using dredge material from the Mississippi River for berm construction to further reduce loss of forested losses in the batture lands; and replanting borrow areas or allowing the borrow areas to revegetate naturally. Maintaining forested corridors within the project area is a particularly important measure since corridors facilitate the movement of bears between fragamented forest patches.

The Service concurs with the Corp's BA, which states that the project would not adversely impact the Louisiana black bear or it's proposed critical habitat as long as the above mentioned measures are incorporated during project construction. However, the Service continues to recommend that loss of forested wetlands should be fully compensated.

Our efforts have have been coordinated with other state and federal agencies. If you have any questions, please contact Daniel Gregg at (601)629-6612.

Sincerely,

Allan J. Mueller

Allan J. Mueller
Field Supervisor

cc: Mississippi Department of Wildlife, Fisheries and Parks, Jackson, M
Attn: Bill Quisenberry
FWS, Jackson, MS
Attn: Bob Bowker
FWS, Lafayette, LA
Attn: Terry Rabot
FWS, Atlanta, GA
Black Bear Conservation Committee, Baton Rouge, LA
Attn: Paul Davidson
Regional Administrator, EPA, Dallas, TX
Règional Administrator, EPA, Atlanta, GA
Arkansas Game and Fish Commission, Little Rock, AR
Attn: Dave Criner
Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA
Attn: Blue Watson
LMRCC, Vicksburg, MS
Attn: Ron Nassar

ATTACHMENT 2
LETTER, U.S. FISH AND WILDLIFE SERVICE
AUGUST 28, 1997

United States Department of the Interior

FISH AND WILDLIFE SERVICE
2524 South Frontage Road, Suite B
Vicksburg, Mississippi 39180-5269

IN REPLY REFER TO:

August 28, 1997

Colonel Gary W. Wright
District Engineer
U.S. Army Corps of Engineers
4155 Clay Street
Vicksburg, Mississippi 39180-3435

Dear Colonel Wright:

We received Mr. Bill Hobgood's letter dated August 21, 1997, requesting information on the occurrence of any endangered, threatened, or proposed species or their critical habitats in the proposed work area for levee enlargement and berm construction work on the Mississippi River and Tributaries Project which extends from Cape Girardeau, Missouri to the Head of Passes in Louisiana. We have previously concurred with the Corps' generic Biological Assessment (BA), which stated that the project would not adversely impact the Louisiana black bear (*Ursus americanus luteolus*) or its proposed critical habitat as long as specific conservation measures (outlined in the BA) were incorporated during project construction. The following information is provided in accordance with the Endangered Species Act (87 Stat. 884, as amended U.S.C. 1531 et seq.).

The following federally listed species may occur in the project area: the pallid sturgeon (*Scaphirynchus albus*), fat pocketbook pearly mussel (*Potamilus capax*), interior least tern (*Sterna antillarum*), bald eagle (*Haliaeetus leucocephalus*), and wood stork (*Mycteria americana*). The pallid sturgeon is typically found in deep, slow moving rivers and streams (Mississippi River and its tributaries). However, it is known to spawn in relatively shallow water over sand and gravel beds when the water temperature is above 20 degrees centigrade. Specifics on the life history of this species are not complete, but ongoing research should provide more information on this species' needs. Most sturgeon captures have occurred near the mouths of tributaries.

The interior least tern nests on sand and gravel bars within the Mississippi River and its tributaries from approximately May 15 to August 31. It may extend nesting beyond this date depending on the Mississippi River stage elevations. The Memphis District, in conjunction with the U.S. Fish and Wildlife Service, conducts annual surveys for nesting colonies along the Mississippi River to determine population size and distribution. Forty-three nesting colonies were observed between river mile 620 and river mile 304, which includes the project area, during the 1994 survey.

The fat pocketbook pearly mussel occurs in the lower Mississippi River and its side channels. The life history of the species is unknown; however, it most likely is similar to that of other members of the Unionidae family. The most likely bottom habitat is a mixture of sand, silt, and clay. This mussel has an extended breeding season and is reported to become gravid in June, July, August, and October.

The bald eagle uses a large area for hunting and does not adapt to radical changes in its environment. In the Southeast, nesting activities begin in early September. Most nests are located in the upper 30 feet of trees with canopy cover above and a clear view of open water. The cone shaped nests may be six feet in diameter and six to eight feet from top to bottom. Egg laying may begin as early as late October with a peak occurring in late December. Varying with lattitude within the project area, incubation may be initiated from October to March. Incubation is approximately 35 days and fledging takes 10 to 12 weeks (as late as August). Scattered nests are known to currently exist along the Mississippi River.

The wood stork is a highly colonial species usually nesting in large rookeries and feeding in flocks. In 1997 wood storks unsuccessfully attempted to nest at Jones Lake, adjacent to and on the protected side of the levee, in Warren County, Mississippi. This is the only current record of breeding in the project area. The storks do, however, pass through the area as they move northward after breeding, usually from July to October. The eastern (Florida, Georgia, South Carolina) breeding population is listed as endangered, but the Mexican breeding population is not listed. The wood storks that occur in the lower Mississippi River area could be from either population. Further research is needed to determine the origin of our wood storks. Storks are birds of freshwater and brackish wetlands, primarily nesting in cypress or mangrove swamps, and feeding primarily in freshwater marshes, flooded pastures, and flooded ditches. Particularly attractive feeding sites are depressions in marshes or swamps where fish become concentrated during periods of falling water levels. Small fish from one to six inches long, especially top minnows and sunfish, provide this bird's primary diet.

We look forward to working with your agency as project planning continues. If you have any questions, please contact Curtis James at (601) 629-6615.

Sincerely,

Lloyd E. Inmon

Lloyd E. Inmon
Acting Field Supervisor

cc: Regional Administrator, EPA, Dallas, TX
Regional Administrator, EPA, Atlanta, GA
Arkansas Game and Fish Commission, Little Rock, AR
Attn: Craig Uyeda
Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA
Attn: Blue Watson
Mississippi Department of Wildlife, Fisheries and Parks, Jackson, MS
Attn: Wayne Watts
Missouri Dept. of Conservation, Jefferson City, MO
Attn: Gary Cristoff
Tennessee Wildlife Resources Agency, Nashville, TN
Kentucky Dept. of Fish and Wildlife Resources, Frankfort, KY
Illinois Dept. of Natural Resources, Springfield, IL
FWS, Jackson, MS
Attn: Bob Bowker
FWS, Columbia, MO
FWS, Cookeville, TN
FWS, Rock Island, IL
FWS, Lafayette, LA

ATTACHMENT 3
GENERIC BIOLOGICAL ASSESSMENT
LOUISIANA BLACK BEAR

US Army Corps of Engineers
Vicksburg District

July 1998

Generic Biological Assessment for Possible Effects on the Louisiana Black Bear by Completion of Levee Enlargement & Berm Construction Works of the Mississippi River & Tributaries Project within the Vicksburg District

Prepared by:
Vicksburg District
4155 Clay Street
Vicksburg, MS 39183-3435

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
LEVEE ENLARGEMENT AND BERM CONSTRUCTION

GENERIC BIOLOGICAL ASSESSMENT
LOUISIANA BLACK BEAR

JANUARY 1996

GENERIC BIOLOGICAL ASSESSMENT
LOUISIANA BLACK BEAR

INTRODUCTION

1. This Biological Assessment has been prepared to determine the likelihood of an effect on the Louisiana black bear as the result of the continuing levee enlargement and berm construction on the mainline Mississippi River levees in the Vicksburg District. The assessment is based on pertinent information concerning the project and the bear and has been prepared in accordance with Section 7 of the Endangered Species Act of 1973, as amended.

2. Certain data used in this assessment will be updated periodically since the project is not expected to be completed until the year 2020. Examples of the type data that will be updated include land use information as forest statistics for Louisiana parishes and Mississippi counties become available from the U.S. Forest Service, as additional Geographic Information System mapping becomes available on affected batture lands, as additional data are available on bear activity and range extensions become available, as additional mitigation measures are developed, etc. It is expected that this type data will be updated at least every 7 years. This is the interval the U.S. Forest Service uses to update changes in wooded lands.

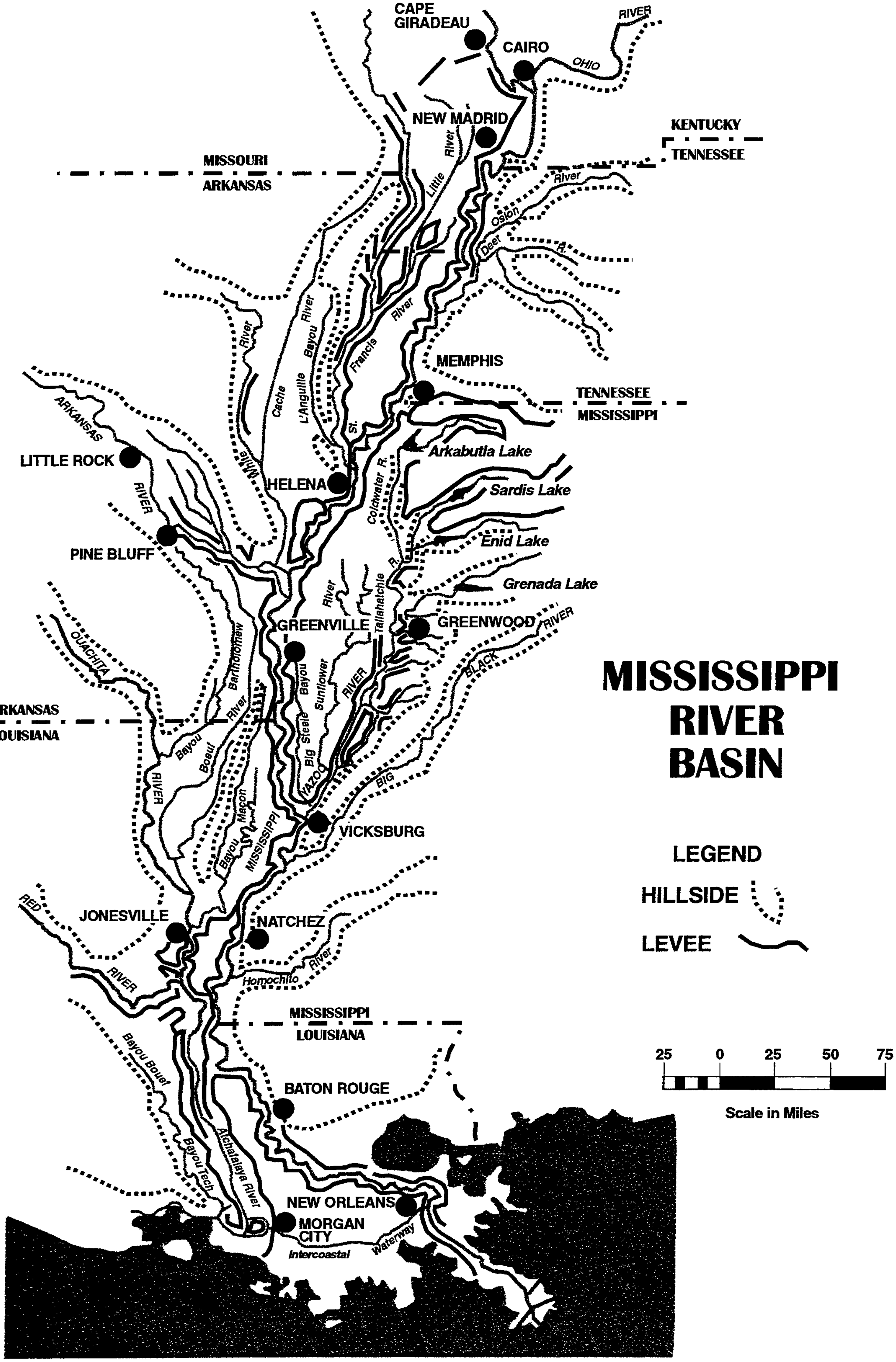
3. Surveys will be conducted by qualified individuals in areas that will be affected by construction to determine the quality of bear habitat and bear usage in areas where it is not known. These surveys will typically be conducted in summer and fall which are peak times for bear feeding activity. Results of these surveys will be used to reassess impacts and develop any needed mitigation measures.

4. The updated data and surveys will be analyzed, and this generic assessment may be revised or more specific biological assessments may be prepared when conditions occur that might affect the conclusion of this assessment.

PROJECT DESCRIPTION AND PURPOSE

5. Following the tremendous flood of 1927, Congress passed the Flood Control Act of 1928 committing the Federal Government to a comprehensive program of flood control and authorizing the Mississippi River and Tributaries Project (MR&T). The MR&T project is designed to control a "project flood" with a discharge of 3 million cubic feet per second in the alluvial valley of the lower Mississippi River (U.S. Army Corps of Engineers, 1987).

6. The MR&T project is composed of four major features--levees, floodways, channel improvement, and tributary basin development. Levees are the backbone of the system and cover more than 2,000 miles along the Mississippi River and its principal tributaries. This system of levees extends from Cape Girardeau, Missouri, to Venice, Louisiana (Figure 1). The purpose of the levees is to confine floodwaters to the main river channel, adjacent batture lands, and designated floodways (U.S. Army Corps of Engineers, 1987). This assessment will discuss the mainline levee work, but will not discuss the channel



MISSISSIPPI RIVER BASIN
CAPE GIRADEAU
CAIRO
OHIO
RIVER
NEW MADRID
KENTUCKY
TENNESSEE
MISSOURI
ARKANSAS
Little River
River
Obion
Deer
R.
Francis River
St.
MEMPHIS
TENNESSEE
MISSISSIPPI
Cache River
L'Anguille Bayou
White River
ARKANSAS RIVER
LITTLE ROCK
HELENA
Arkabutla Lake
Coldwater R.
Sardis Lake
Enid Lake
Grenada Lake
PINE BLUFF
Tallahatchie River
R.
GREENVILLE
GREENWOOD
RIVER
BLACK
OUACHITA
Bartholomew
River
Bayou Sunflower
RIVER
Big Steele Bayou
YAZOO
BIG
ARKANSAS
LOUISIANA
Bayou Boeuf
RIVER
Bayou Macon
MISSISSIPPI
VICKSBURG
LEGEND
HILLSIDE
LEVEE
RED
JONESVILLE
NATCHEZ
RIVER
Homochitto River
MISSISSIPPI
LOUISIANA
Bayou Bouef
25 0 25 50 75
Scale in Miles
BATON ROUGE
Bayou Tech
Atchafalaya River
NEW ORLEANS
MORGAN CITY
Intercoastal Waterway

Figure 1

improvement and tributary basin development features as the channel improvement features will not adversely impact the bear and separate biological assessments are prepared for projects on tributaries of the main stem.

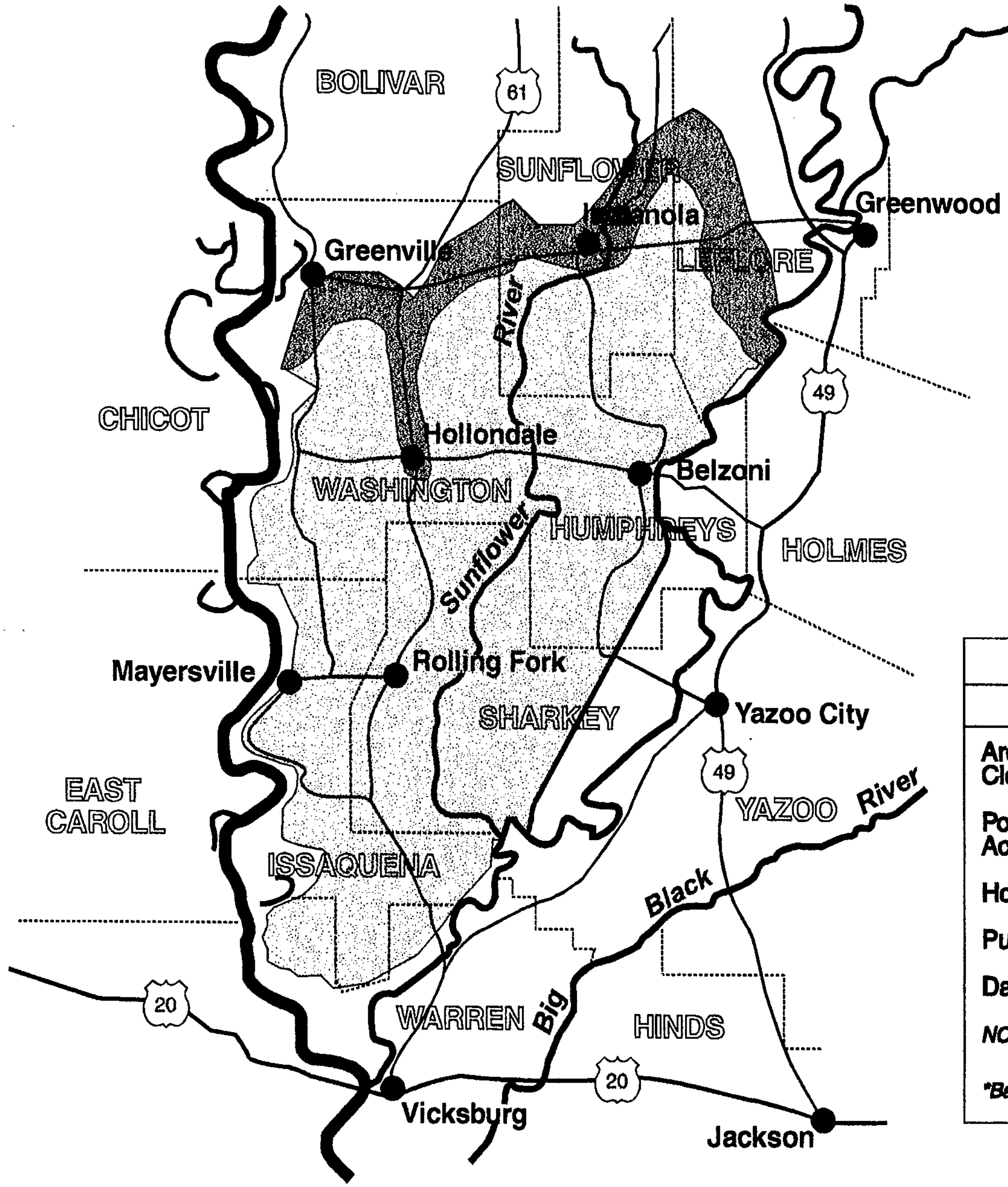
7. On the west bank of the river, the mainline Mississippi River levees begin just south of Cape Girardeau and, except where the waters of the St. Francis and the Arkansas-White Rivers join the Mississippi River and at Old River where the Atchafalaya River discharges from the Mississippi River, with its incorporated structures, extend unbroken to Venice. On the east bank of the river, the levees alternate with high bluffs to give protection from floods (U.S. Army Corps of Engineers, 1979).

8. Berms--earthen shoulders at the bottom of the levee--are constructed adjacent to the levees at certain locations where underseepage and/or stability is a problem. The seepage berms are located landside of the levee and stability berms can be located either landside or riverside, depending upon conditions at the particular site (U.S. Army Corps of Engineers, 1976).

9. Levee enlargements and berms are generally constructed from fill material obtained from borrow areas located on the riverside of the levee. Where no adjacent riverside borrow is available, borrow areas are located on the landside of the levee. Typical levee enlargement and berm sections for riverside and landside enlargements are shown on Figure 7. Levee enlargement and berm sections are constructed by mechanical means (usually scrappers and/or track excavators loading trucks to transport the material) in accordance with the construction plans and specifications. A degree of compaction is required for levees and stability berms. No compaction is required for seepage berms. After the levee enlargement and berm are to grade and section, the surface is seeded or sodded to provide a vegetative cover for protection. This same operation applies in cases where upgrading includes moving the levee away from the river (levee setback) because of instability caused by the cutting action of the river (U.S. Army Corps of Engineers, 1976).

10. A major flood occurred on the lower Mississippi River from early March 1973 until mid-June 1973. Although still incomplete, the MR&T project for flood control on the lower Mississippi River, overall, performed splendidly during this flood. However, as the flood developed and stage-discharge relation data were collected and analyzed, it became apparent that the channel capacity of both the lower Mississippi River and the lower portion of the Atchafalaya Basin Floodway had seriously deteriorated. A new design flood flow line was established, and it demonstrated the need to raise many miles of levees to provide protection against the project flood (U.S. Army Corps of Engineers, 1973). Damages that would occur within the Vicksburg District if the levees would experience crevasses in Mississippi and Louisiana exceed $4 billion (Figures 2 and 3). The needed levee enlargement began in 1973 and is estimated to be complete in the year 2020. General locations of levee segments that will be raised in the Vicksburg District are shown on Figure 4.

Mississippi River Levee Crevasse Estimated Damages And Effects



El. 116 - Area Flooded Project Conditions

El. 123 - Area Flooded Levee Crevasse Near Mayersville

Item	Flood Elevation (feet) 116	123
Area Flooded, Total Acres	1,282,000	1,417,000
Cleared Acres	1,103,000	1,231,000
Population within Inundated Acres (No.)	47,000	79,000
Homes Flooded (No.)	15,000	25,000
Public Roads Flooded (miles)	1,700	2,000
Damages*	$1,962,600,000	$3,042,000,000

NOTE: Additionally, 28,000 acres are adversely effected due to high velocity flows within immediate area of crevasse.

**Based on May 1995 dollar values.*

Figure 2

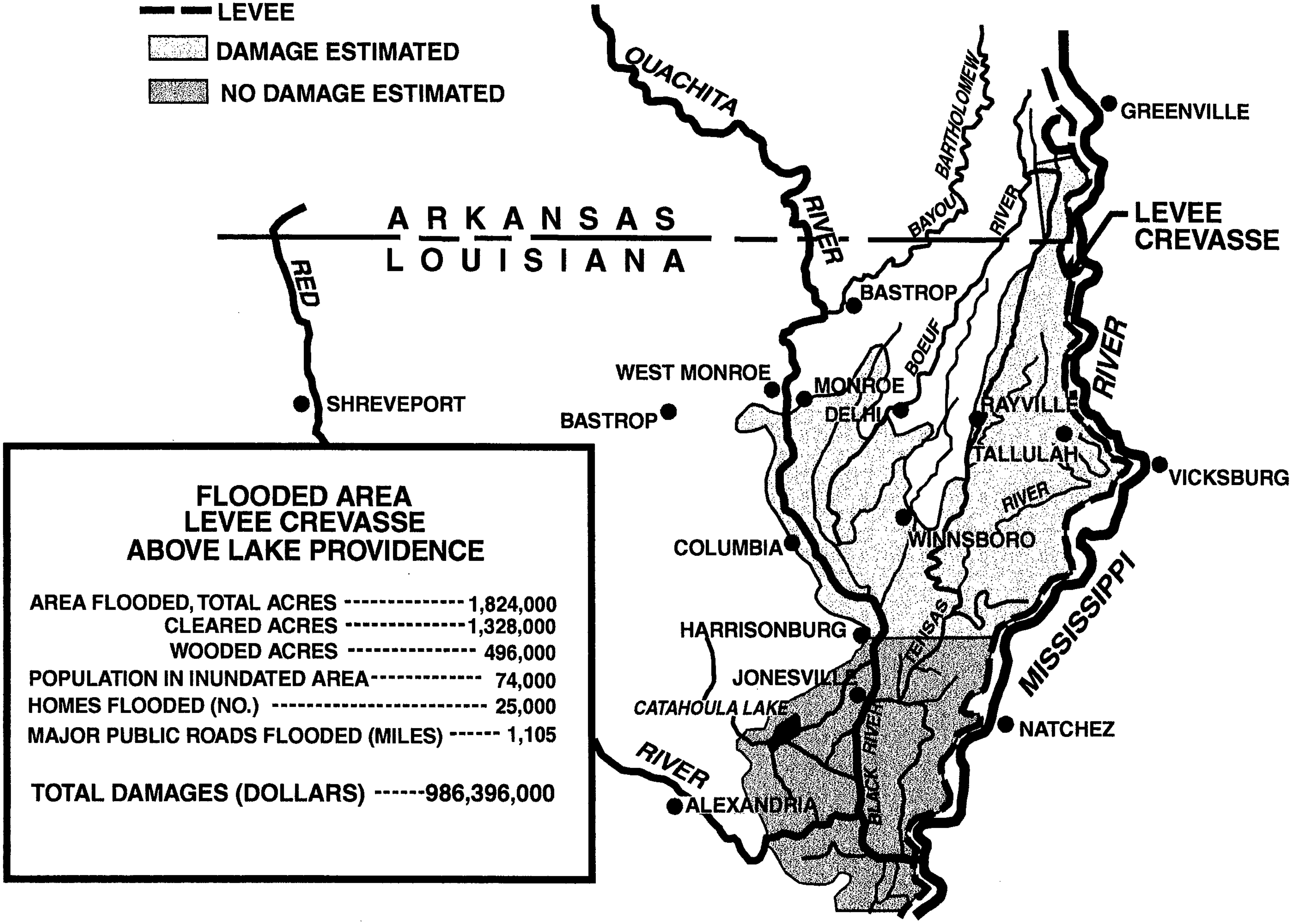

LEVEE
DAMAGE ESTIMATED
NO DAMAGE ESTIMATED
ARKANSAS
LOUISIANA
QUACHITA
RIVER
BAYOU
BARTHOLOMEW
RIVER
RED
GREENVILLE
LEVEE CREVASSE
BASTROP
BOEUF
WEST MONROE
MONROE
DELHI
RAYVILLE
SHREVEPORT
BASTROP
TALLULAH
VICKSBURG
RIVER
COLUMBIA
WINNSBORO
RIVER
HARRISONBURG
TENSAS
MISSISSIPPI
JONESVILLE
CATAHOULA LAKE
NATCHEZ
RIVER
BLACK RIVER
ALEXANDRIA
FLOODED AREA
LEVEE CREVASSE
ABOVE LAKE PROVIDENCE
AREA FLOODED, TOTAL ACRES -------------- 1,824,000
CLEARED ACRES -------------- 1,328,000
WOODED ACRES --------------- 496,000
POPULATION IN INUNDATED AREA ------------- 74,000
HOMES FLOODED (NO.) ------------------------- 25,000
MAJOR PUBLIC ROADS FLOODED (MILES) ------ 1,105
TOTAL DAMAGES (DOLLARS) ------986,396,000

Figure 3

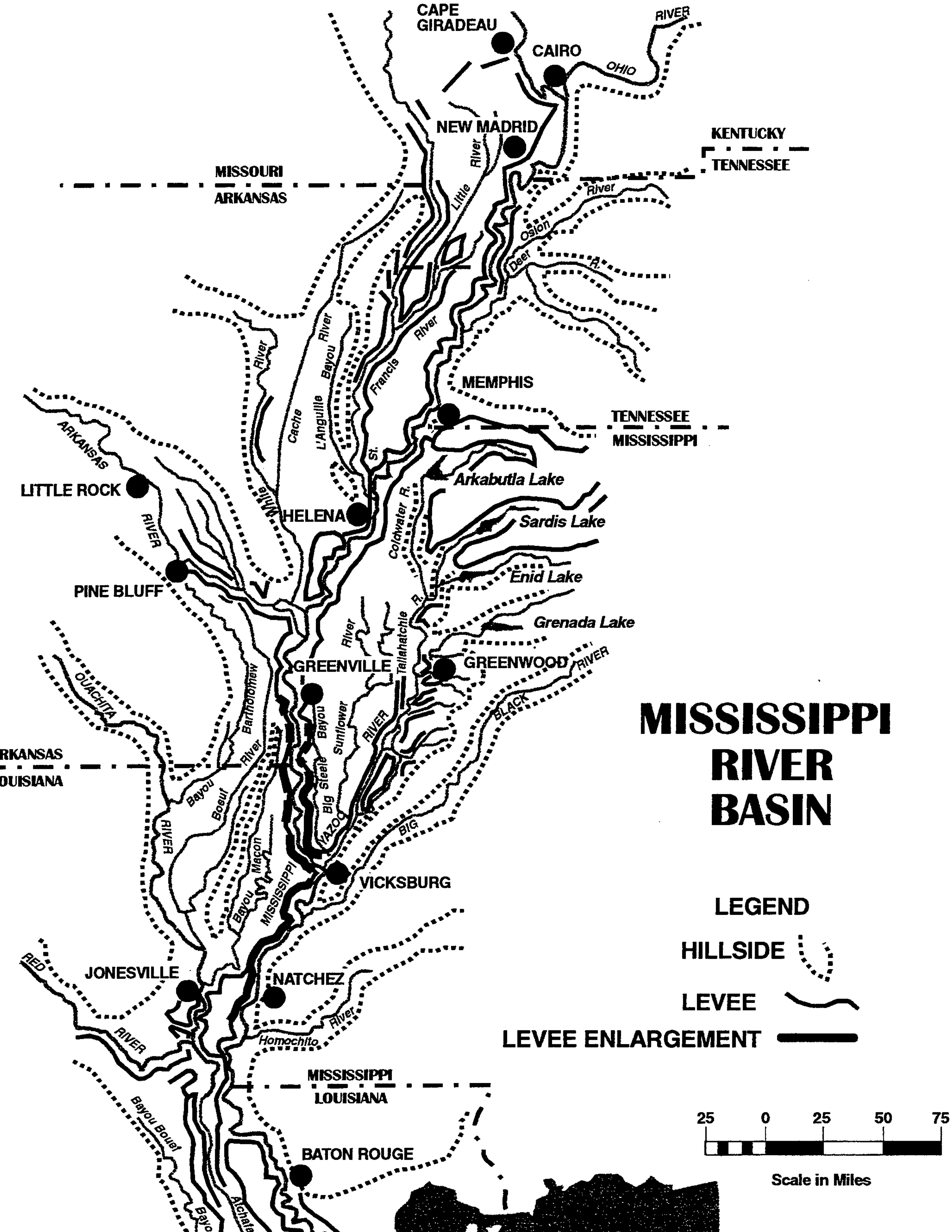

MISSISSIPPI
RIVER
BASIN
LEGEND
HILLSIDE
LEVEE
LEVEE ENLARGEMENT
25 0 25 50 75
Scale in Miles
CAPE GIRADEAU
CAIRO
OHIO RIVER
NEW MADRID
KENTUCKY
TENNESSEE
MISSOURI
ARKANSAS
Little River
Obion River
Deer R.
St. Francis River
Bayou River
L'Anguille
Cache River
MEMPHIS
TENNESSEE
MISSISSIPPI
Arkabutla Lake
Sardis Lake
Enid Lake
Grenada Lake
Coldwater R.
Tallahatchie R.
ARKANSAS RIVER
LITTLE ROCK
HELENA
PINE BLUFF
GREENVILLE
GREENWOOD
Bayou Sunflower
Big Steele Bayou
YAZOO RIVER
BLACK RIVER
BIG
OUACHITA RIVER
Bartholomew River
Bayou Boeuf
Bayou Macon
MISSISSIPPI
ARKANSAS
LOUISIANA
VICKSBURG
JONESVILLE
NATCHEZ
RED RIVER
Homochitto River
MISSISSIPPI
LOUISIANA
BATON ROUGE
Bayou Bouef
Bayou Tech
Atchafalaya River
NEW ORLEANS
MORGAN CITY
Intercoastal Waterway

Figure 4

The north and south boundaries of the Vicksburg District in the Mississippi River Basin are shown on Figure 5. Locations of remaining berms that will be constructed as the levees are enlarged in the District are shown on Figure 6.

11. Illustrations depicting how the levees are typically raised and how berms are constructed on either side of the levee are shown on Figure 7. There were 73.5 miles of mainline levees deficient in the Vicksburg District within the State of Mississippi after 1973. Approximately 6 percent of this work in Mississippi has been completed. A total of 192.8 miles of levees needed to be raised in the District within the State of Louisiana following the 1973 flood. To date, 131.6 miles remain to be raised in Louisiana. The levees in Mississippi were deficient 2 to 8 feet in height depending upon location. Those in Louisiana were 2 to 9 feet deficient in height to protect from the project flood. While some levee and berm construction is needed in the District in Arkansas, this work will not be evaluated in this assessment since the black bear is not considered a threatened species in that state.

12. As stated earlier, the levees divert excess flows in four critical locations where floodways have been constructed--the northernmost is Birds Point-New Madrid in Missouri which was used once in 1937. The remaining three floodways are in Louisiana--West Atchafalaya, Morganza, and Bonnet Carre. The West Atchafalaya Floodway has never been used, and the Morganza Floodway was used once in 1973. However, the Bonnet Carre Floodway, located upstream of New Orleans, Louisiana, was the first floodway completed and has been opened several times (U.S. Army Corps of Engineers, 1987).

THE LOUISIANA BLACK BEAR

13. The following paragraphs in this section present pertinent information about the Louisiana black bear's status and habits that were considered in this assessment.

14. The Louisiana black bear, Ursus americanus luteolus--one generally recognized subspecies of the American black bear--historically occurred in bottom-land forests from eastern Texas through all of Louisiana to southern Mississippi (Hall, 1981).

15. Its historical range in the Vicksburg District is shown on Figure 8. The U.S. Fish and Wildlife Service (FWS) determined the Louisiana black bear to be a threatened species within its historic range in 1992. This determination was made primarily because the habitat of the bear has suffered extensive modification with suitable habitat having been reduced by more than 80 percent as of 1980. The remaining habitat has been reduced in quality by fragmentation due to intrusion of man and his structures.

16. The Louisiana black bear ranges over large areas of Louisiana and Mississippi. Although individual bears travel great distances and are considered habitat "generalists" utilizing a diversity of habitats, they require large areas of relatively undisturbed forest (FWS, 1992). Presently, permanently occupied bear habitat in the Vicksburg District consists of an

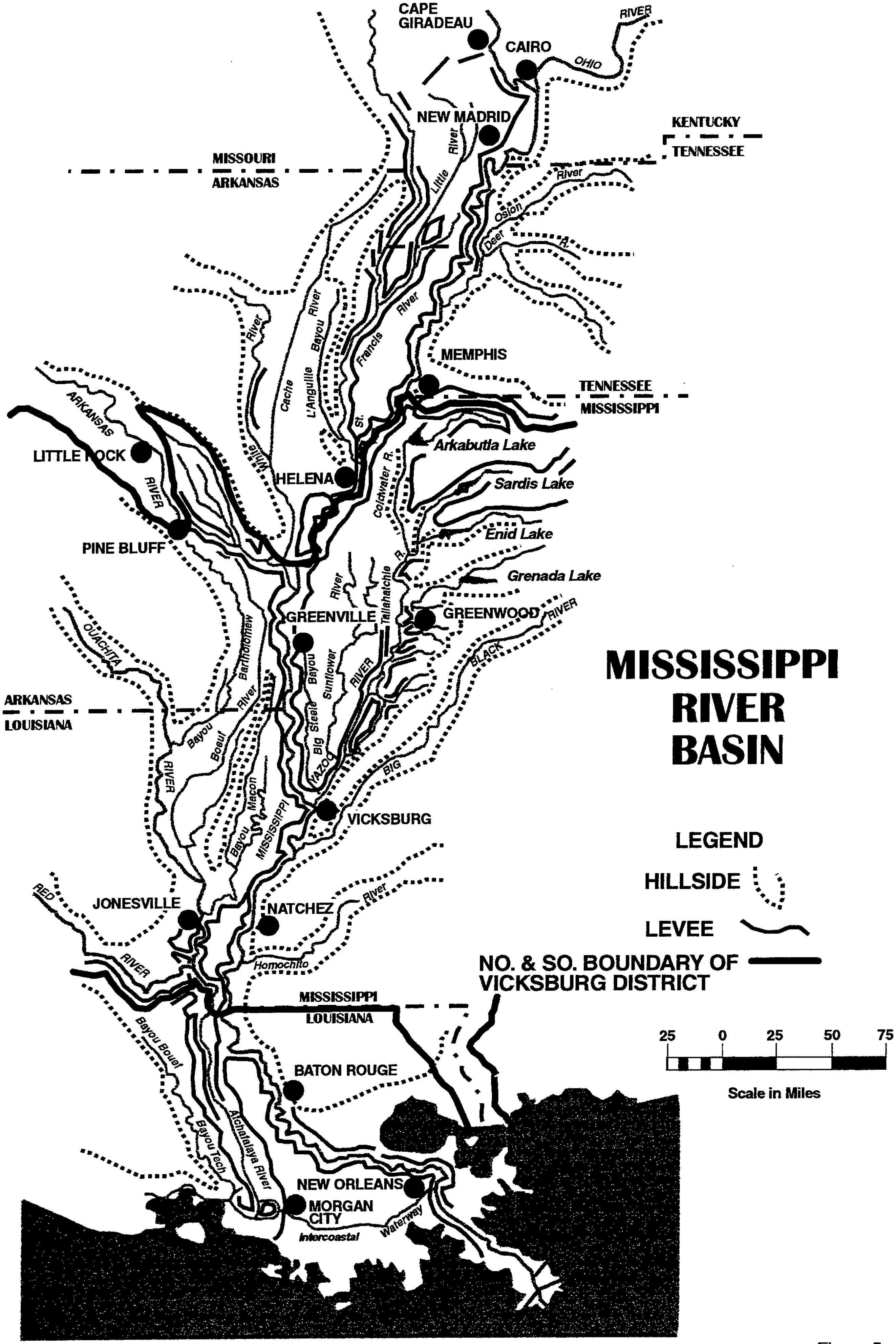
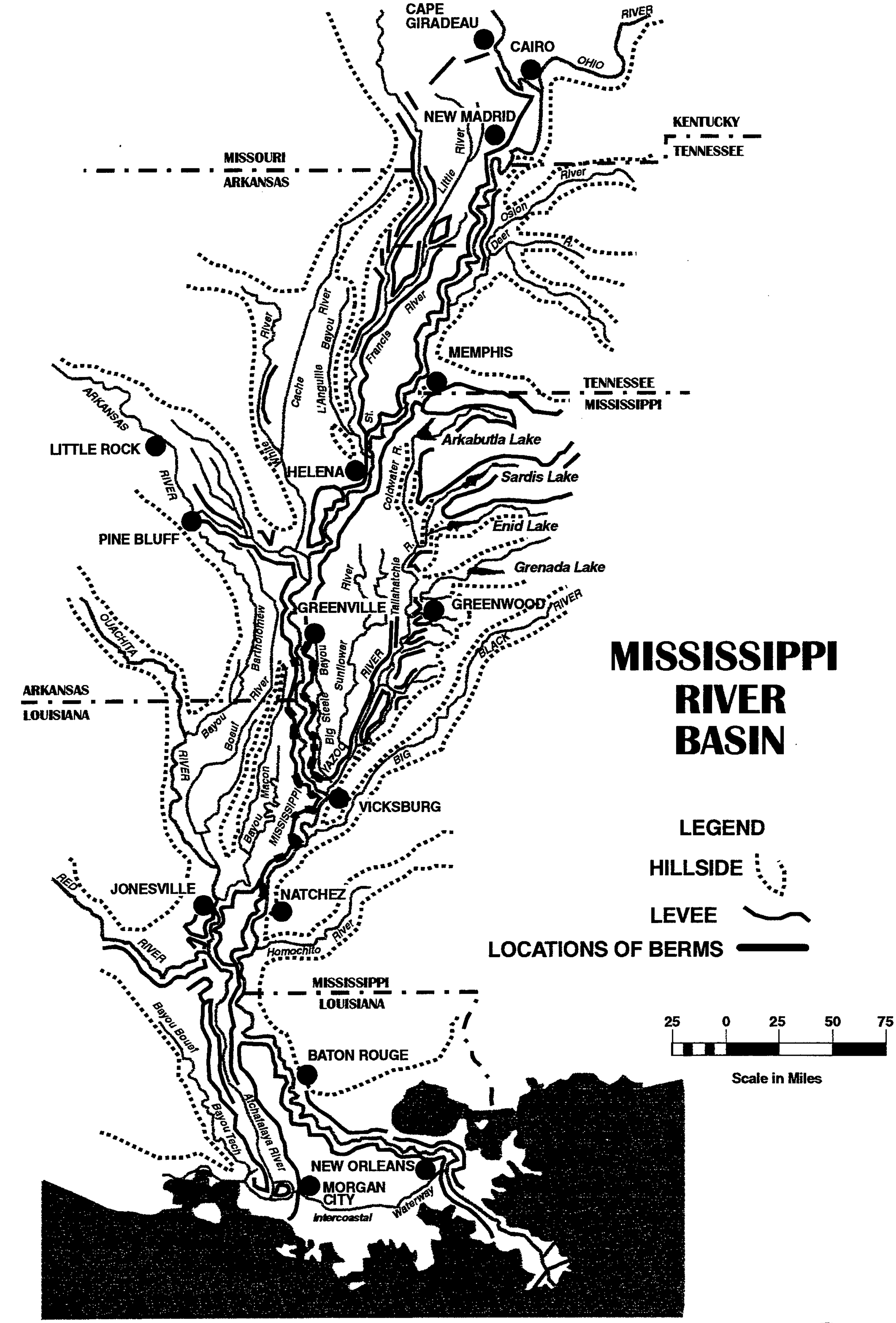

MISSISSIPPI
RIVER
BASIN
LEGEND
HILLSIDE
LEVEE
NO. & SO. BOUNDARY OF
VICKSBURG DISTRICT
25 0 25 50 75
Scale in Miles
CAPE
GIRADEAU
CAIRO
OHIO
RIVER
NEW MADRID
KENTUCKY
TENNESSEE
MISSOURI
ARKANSAS
Little River
River
Obion
Deer
R.
St. Francis River
Bayou River
L'Anguille
Cache
River
White
MEMPHIS
TENNESSEE
MISSISSIPPI
ARKANSAS
LITTLE ROCK
RIVER
Arkabutla Lake
HELENA
Coldwater R.
Sardis Lake
Enid Lake
PINE BLUFF
Grenada Lake
R.
Tallahatchie
River
GREENVILLE
GREENWOOD
RIVER
BLACK
OUACHITA
Bartholomew
River
Bayou
Sunflower
RIVER
ARKANSAS
LOUISIANA
Bayou
Boeuf
Big Steele
YAZOO
BIG
RIVER
Bayou
Macon
MISSISSIPPI
VICKSBURG
RED
JONESVILLE
NATCHEZ
River
RIVER
Homochitto
MISSISSIPPI
LOUISIANA
Bayou Bouef
BATON ROUGE
Bayou Tech
Atchafalaya River
NEW ORLEANS
MORGAN
CITY
Intercoastal
Waterway

Figure 5


CAPE GIRADEAU
CAIRO
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Cache River
L'Anguille Bayou River
White River
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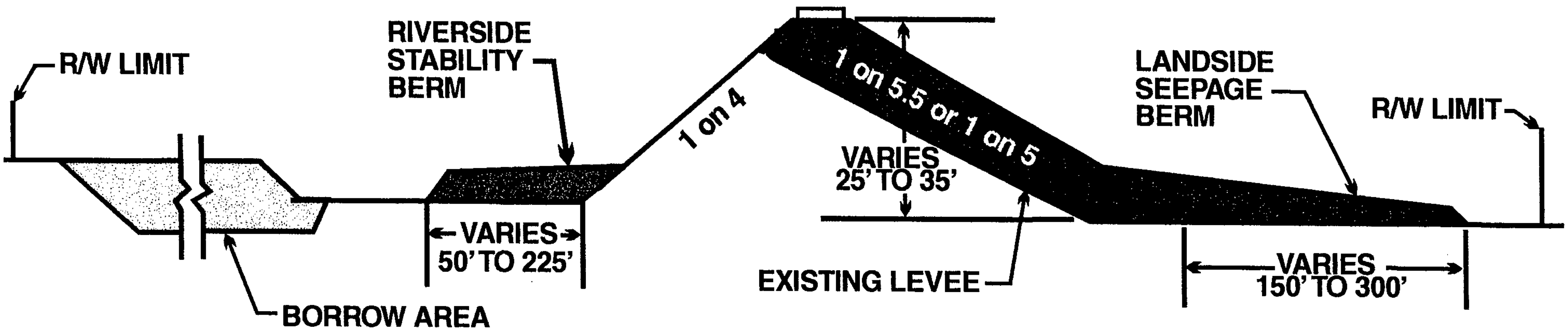
MISSISSIPPI
ARKANSAS
LITTLE ROCK
RIVER
Arkabutla Lake
Coldwater R.
Sardis Lake
HELENA
PINE BLUFF
Enid Lake
Grenada Lake
Tallahatchie R.
River
GREENVILLE
GREENWOOD
RIVER
BLACK
OUACHITA
Bartholomew
Bayou Sunflower
YAZOO RIVER
Big Sunflower
Big Steele
ARKANSAS
LOUISIANA
Bayou
Boeuf
River
RIVER
BIG
Macon
Bayou
MISSISSIPPI
VICKSBURG
JONESVILLE
NATCHEZ
RED
RIVER
Homochitto
River
MISSISSIPPI
LOUISIANA
Bayou Bouef
BATON ROUGE
Bayou Tech
Atchafalaya River
NEW ORLEANS
MORGAN CITY
Intercoastal
Waterway
MISSISSIPPI RIVER BASIN
LEGEND
HILLSIDE
LEVEE
LOCATIONS OF BERMS
25
0
25
50
75
Scale in Miles

Figure 6

TYPICAL LANDSIDE ENLARGEMENT



TYPICAL RIVERSIDE ENLARGEMENT

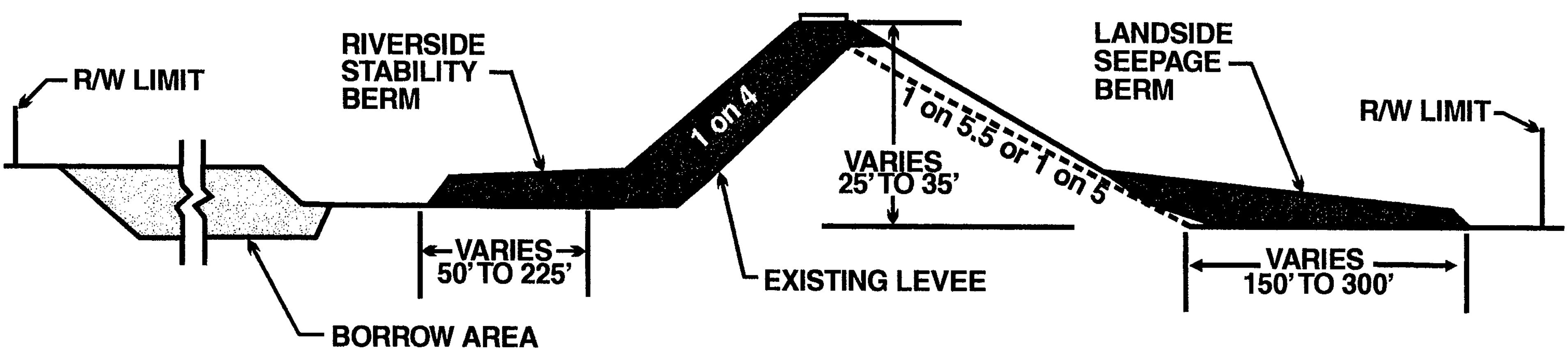
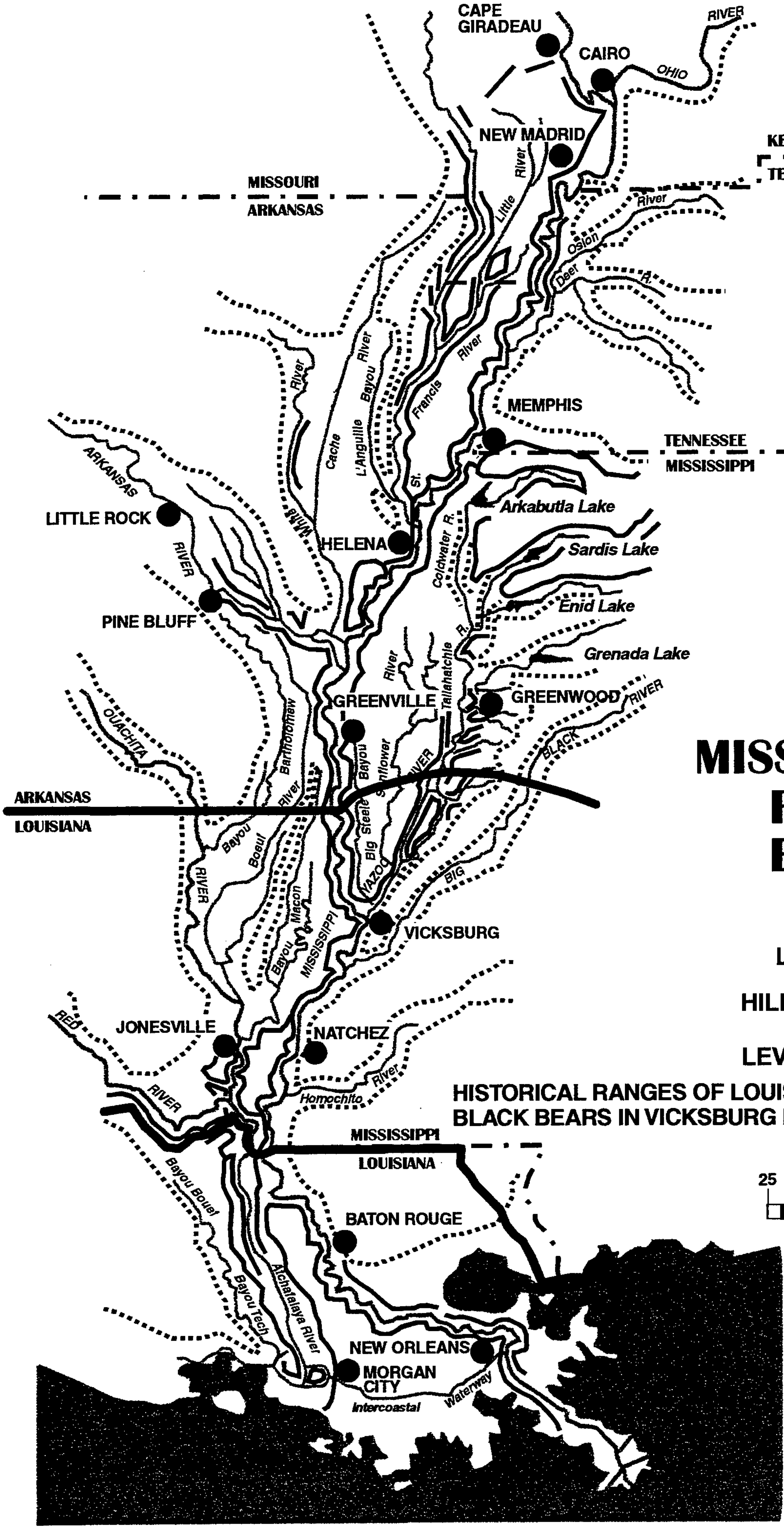


Figure 7



MISSISSIPPI RIVER BASIN

LEGEND

HILLSIDE

LEVEE

HISTORICAL RANGES OF LOUISIANA BLACK BEARS IN VICKSBURG DISTRICT

25 0 25 50 75

Scale in Miles

Figure 8

area within the Tensas River Basin in Louisiana (Figure 9). In addition, areas where occasional and individual sightings have been reported in the District are also shown.

17. The size and shape of a bear's home range are determined by the capability of an area to provide the animal's annual needs (Hamilton, 1978). Home ranges may also vary considerably, depending on such factors as sex, age, season, and population density. Because these factors change, so does the home range size for an individual. Preliminary estimates of home range sizes in the Tensas River Basin indicate adult males may utilize as little as 1,500 to 40,000 acres and adult females from 500 to 18,000 acres (Black Bear Conservation Committee, 1992). These ranges include combinations of forested and open lands.

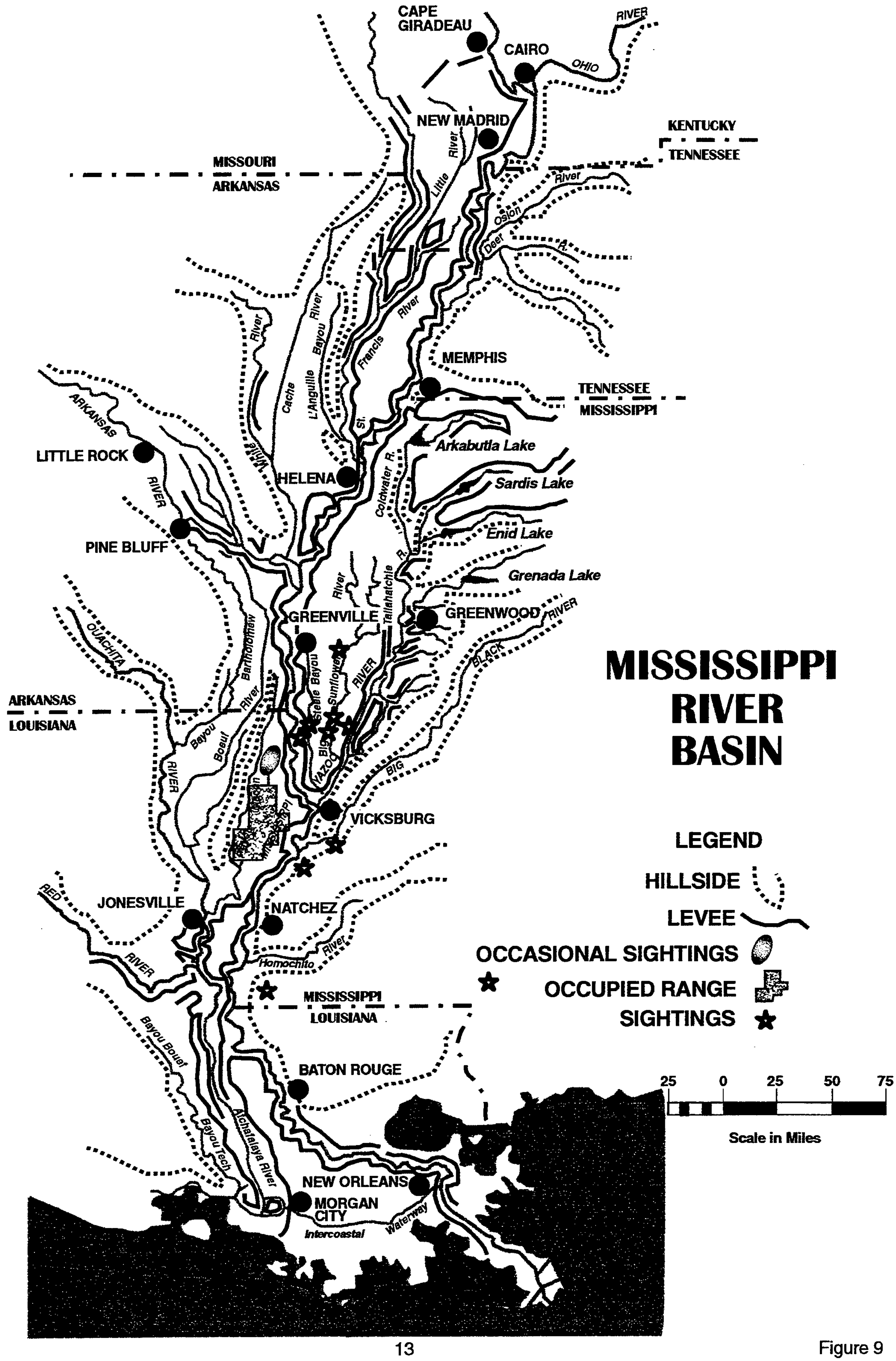
18. Bears exhibit daily and seasonal movements within their home range. Daily movements of black bears are influenced greatly by temperature. They move and feed primarily during the cool of evening and morning hours. Seasonal movements are made primarily to food sources such as mast crops and areas of high berry production (Schmidt and Gilbert, 1981).

19. Black bears require a higher degree of remoteness or seclusion than many other species. This remoteness is provided by areas that have low human population densities, limited access, thick shrub coverage, and rugged topography. When this remoteness is present and the area encompasses the annual food needs for the species, one can expect a viable, healthy bear population (Black Bear Conservation Committee, 1991).

20. Research has shown that at 2 years of age male bears may travel considerable distances to establish a territory of their own. When bears explore new areas, they frequently choose river bottom lands as travel corridors, probably due to the cover, food, and potential densites provided by these dense areas (Black Bear Conservation Committee, 1991).

21. While the subspecies is considered primarily a bottom-land subspecies, it makes some use of upland pine, mixed, and hardwood forests; coastal flatwoods; and marsh habitat. Some agricultural lands next to or interspersed with forested tracts can serve to improve and expand existing bottom-land and upland habitat. Black bears will use all stages of development of bottom-land hardwood stands. A diversity of plant species is an important component of quality bear habitat (Black Bear Conservation Committee, 1992).

22. The components of prime black bear habitat include food, water, cover, denning sites, and limited human access. However, the availability of water is generally not a consideration in coastal plain habitats like the ones in the Mississippi River Basin.



MISSISSIPPI
RIVER
BASIN
CAPE GIRADEAU
CAIRO
OHIO RIVER
NEW MADRID
KENTUCKY
TENNESSEE
MISSOURI
ARKANSAS
Little River
Obion River
Deer R.
St. Francis River
Cache River
L'Anguille River
Bayou
White River
MEMPHIS
TENNESSEE
MISSISSIPPI
ARKANSAS RIVER
LITTLE ROCK
HELENA
Arkabutla Lake
Coldwater R.
Sardis Lake
Enid Lake
Grenada Lake
PINE BLUFF
Tallahatchie R.
GREENVILLE
GREENWOOD
Sunflower RIVER
BLACK RIVER
OUACHITA
Bartholomew
Bayou Boeuf River
Steele Bayou
BIG YAZOO
BIG
ARKANSAS
LOUISIANA
RIVER
VICKSBURG
MISSISSIPPI
LEGEND
HILLSIDE
LEVEE
OCCASIONAL SIGHTINGS
OCCUPIED RANGE
SIGHTINGS
RED RIVER
JONESVILLE
NATCHEZ
Homochito River
MISSISSIPPI
LOUISIANA
Bayou Bouef
Bayou Tech
Atchafalaya River
BATON ROUGE
NEW ORLEANS
MORGAN CITY
Intercoastal Waterway
25 0 25 50 75
Scale in Miles

Figure 9

23. Bears are best described as opportunistic feeders which will eat almost any available food. They spend considerable time foraging for food. Bears utilize all levels of the forest for feeding. They are excellent tree climbers and can gather foods from treetops and vines. In the fall, hard mast is a particularly important fat and carbohydrate-rich food source that provides the fat reserves necessary for bears to enter the denning period in proper health. The hard mast is considered a critical food source at this time (Black Bear Conservation Committee, 1992). Foods provided by bottom lands that are important to black bears are depicted in Table 1 (Black Bear Conservation Committee, 1992).

TABLE 1
IMPORTANT BOTTOM-LAND PLANTS

Crop Trees	Mid-Story	Understory	Planted
Nuttall Oak	Sassafras	Blackberry	Clovers
Willow Oak	Red Mulberry	Dewberry	Grasses (Bayhia)
Water Oak	Dogwood	Pokeweed	Wheat
Cherrybark Oak	Persimmon	Elderberry	Rye grass
Overcup Oak	Blackgum	Greenbriar	Corn
Cow Oak	Mayhaw	Devil's Walking Stick	Milo
White Oak	Rattan	French Mulberry	Oats
Shumard Oak	Muscadine	Palmetto	Sugarcane
Sweet Pecan	Wild Grape		Hardwood Plantations
Hickory	Poison Ivy		
Cypress	Pawpaw		
Swamp Tupelo	Holly		
	Wild Plums		

24. Thick understories prevalent in coastal plain forests usually provide adequate natural cover to afford bears areas of retreat that ensure little chance of close contact or visual encounters with humans (Black Bear Conservation Committee, 1992).

25. Most radio-collared adult female bears in the Tensas River Basin selected hollow cypress trees with cavity entrances 20 to 90 feet above ground level as dens. Den trees are usually located in sloughs, bayous, or wooded flats. Bears not denning in trees use brush piles created from felled treetops or ground nests in thick cover. These nests are shallow, scooped-out depressions, either bare or lined with vegetation bitten off around the nest site and placed in the nest in a wreath-like fashion. Bears using this type of den frequently change locations during the denning period in the winter. Radio-telemetry data on the Tensas Delta National Wildlife Refuge reveal that use of these nest sites is often in areas of recent logging activity (1 to 5 years). Approximately 30 percent of the bears used brush pile and ground nest winter dens. Brush pile dens were made in logged treetops, and ground nests were made next to discarded logs or in thick briar and vine growth in logged areas. The onset of denning in the Tensas River Basin occurs from late November to February (Weaver, 1990).

26. The reproductive biology of the Louisiana black bear is not well known (FWS, 1994). Most reproductive characteristics of the bear are assumptions based upon studies of black bears elsewhere. Mating generally occurs in the summer months. After a gestation period of 7 to 8 months, the cubs are born in winter dens in January and February. Litter sizes in the Tensas River Basin range from one to three. Cubs emerge from the den with their mother in the spring and stay with her throughout the year suckling and later, eating solid foods. They den with her the following winter, emerge with her again in the spring, and live with her until the summer when the family unit dissolves.

27. Black bears are not considered to be true hibernators; however, they do go through a winter dormancy period which helps them survive food shortages and severe winter weather. Black bears exhibit varying degrees of lethargy while denning, but most can be easily roused if disturbed. One-third of the radio-collared bears in the Tensas River Basin remained "semiactive" during the winter, only denning for short, intermittent periods. Data collected from monitoring den behavior indicate bears may be more active in the Tensas River Basin than at more northern latitudes (Black Bear Conservation Committee, 1992).

28. Because of their generally sparse numbers, characteristically shy, secretive nature, and inaccessible habitat, black bears are difficult to census (Pelton, 1982). However, southeastern wetland black bear population densities are on the order of 1 to 4 bears per 10 square kilometers (1 to 4 bears per 2,471 acres) (Hellgren, 1988). The population estimate of the Tensas River Basin stands at approximately 60 to 100 bears, with approximately

100,000 to 69,500 acres of bottom-land forests remaining in the Basin. In 1992, it was estimated that 200 to 300 bears remained in Louisiana in the Atchafalaya and Tensas River Basins and 25 to 50 bears were scattered in the Mississippi, Pearl, and Pascagoula River drainages (Black Bear Conservation Committee, 1992).

29. Black bear natural mortality varies among age classes. Subadults are the most vulnerable, especially after families break up. Cub mortality is usually low. Jonkel and Cowan (1971) found that annual cub mortality in black bear populations was only 5 percent, and annual adult mortality was 14 percent. Average annual mortality for all age classes was found to be 17.7 percent.

30. On 2 December 1993, FWS proposed to designate critical habitat for the Louisiana black bear. Section 3 of the Endangered Species Act defines critical habitat as the specific areas containing the physical and biological features essential to the conservation of the species and which may require special management considerations or proteetion (FWS, 1992). Figure 10 shows the general location for the portion of proposed critical habitat that is within the Vicksburg District. The Endangered Species Act of 1973 prohibits Federal agencies from taking actions that are likely to jeopardize the continued existence of a listed species or result in destruction or adverse modification of habitat designated as critical.

31. In 1992, bear population trends were unknown for the States of Louisiana and Mississippi. To date, reproduction has been documented in both states and, black bears are making a comeback in the lower Mississippi River Basin. This is due largely to the efforts of state and Federal agencies, conservation organizations, universities, timber companies, farmers, and other private landowners (Black Bear Conservation Committee, 1995).

PROBABLE IMPACTS TO THE LOUISIANA BLACK BEAR

32. Subsequent paragraphs discuss the probable impacts of the remaining levee and berm work of the MR&T project in the Vicksburg District on the black bear. Impacts on the bear's movements, home range, travel corridors, foods, cover, forested habitat, denning sites, reproductive biology, hibernation, density, proposed critical habitat, mortality, and population trends are all discussed.

33. The bear crosses some agricultural fields and wooded corridors when moving over large areas of Louisiana and Mississippi and utilizes relatively large home ranges. The project, as currently planned, will result in some agricultural fields in the rights-of-way being reforested which should improve their desirability to bears. Nearly all acres of forested areas that will be cleared for borrow material will have equivalent acres either allowed to revert back to bottom-land hardwoods or be planted with suitable riverfront hardwoods; hence, any large forested areas that will be affected should remain the same size (Figure 11). In addition, plans will be made that retain all

MISSISSIPPI RIVER BASIN

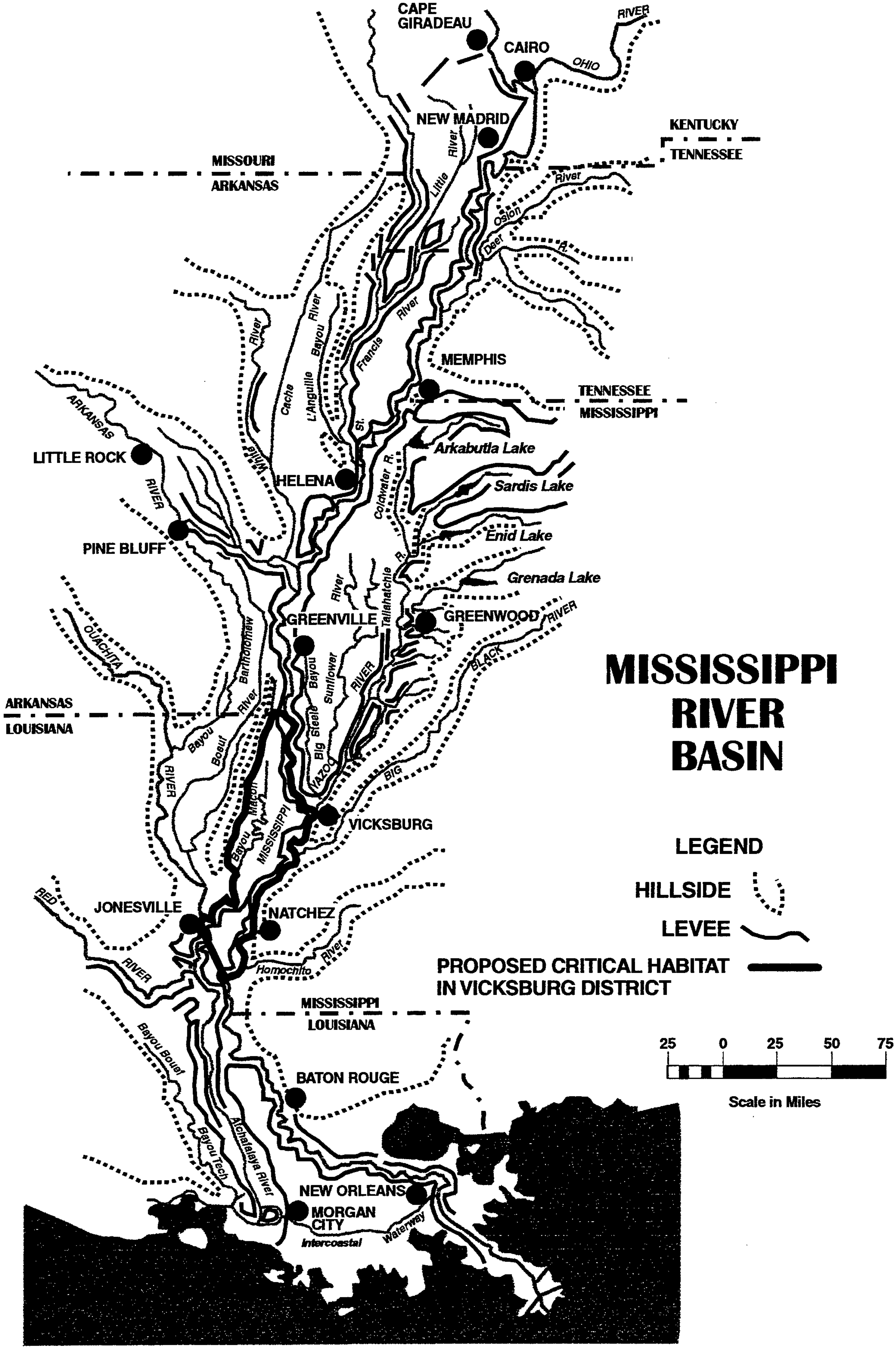
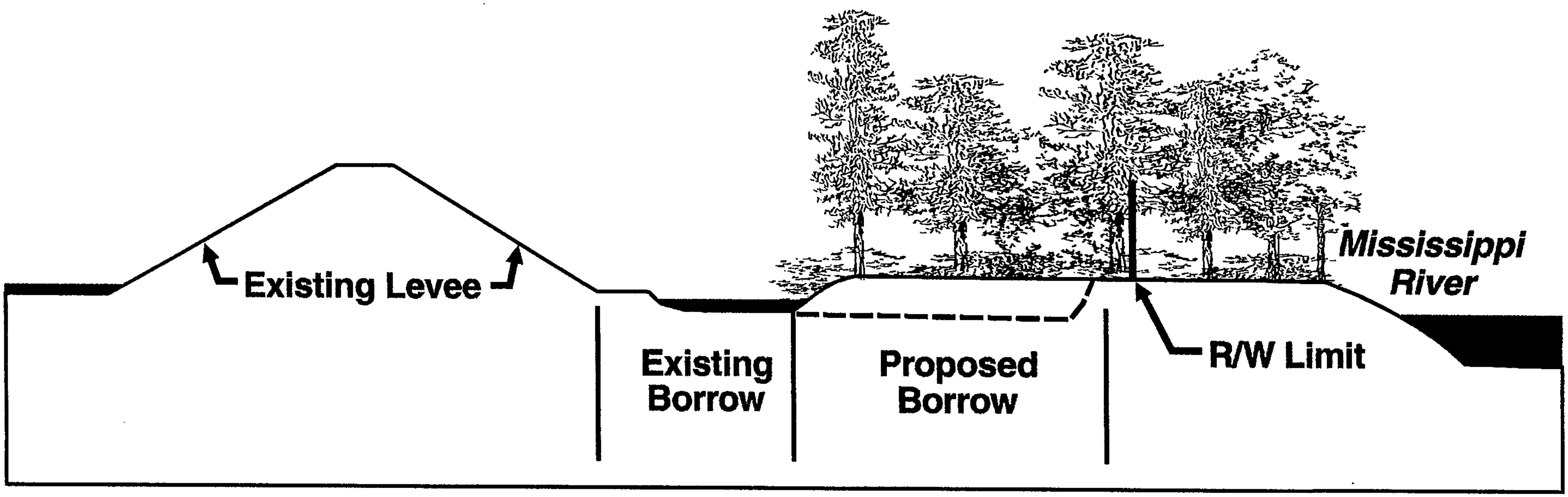


Figure 10

Borrow Area Reforestation



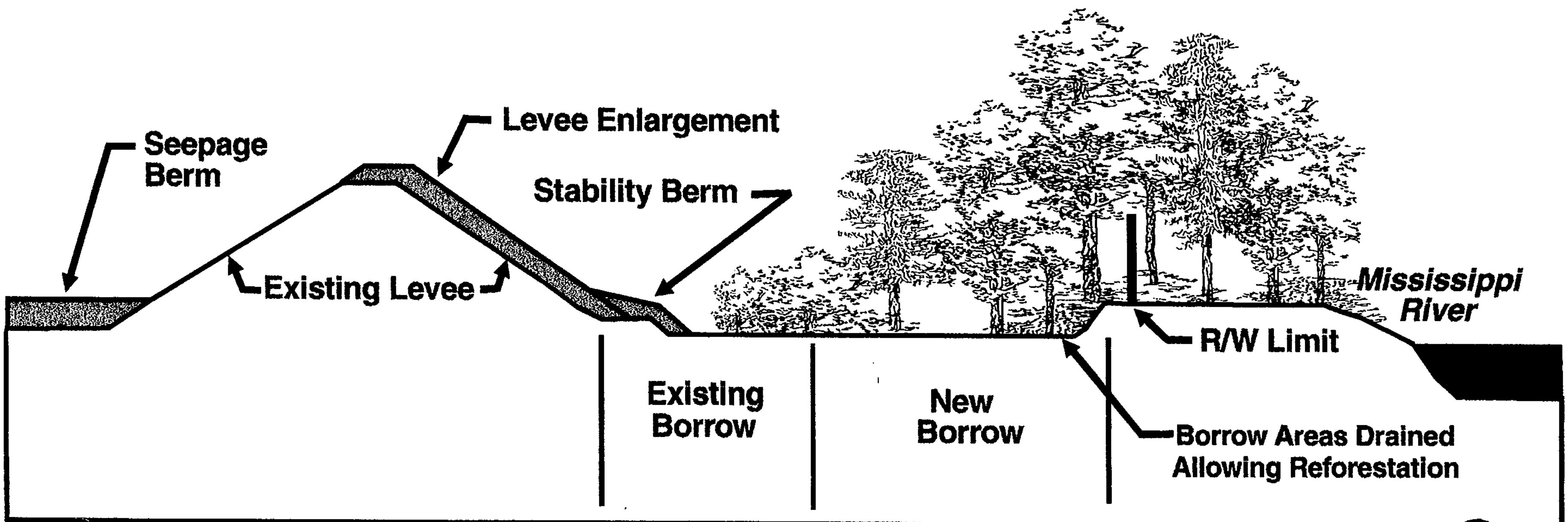


Figure 11

wooded corridors in the projects right-of-way. By taking these measures, there should not be any effect on the ability of the bear to make long-range movements or occupy large wooded areas in the study area.

34. The remaining construction works should not affect population density or the capability of areas to meet bears' needs for travel. Only about three levee items will be under construction each year. This work would generally affect an average of 140 acres of woodlands annually, or .01 percent of the total bottom-land hardwoods of the Mississippi River Basin in the Vicksburg District. In the early 1990's, there were approximately 2,876,700 acres of bottom-land hardwoods in the portion of the Mississippi River Basin (Figure 1) in the Vicksburg District. Of this total, 508,406 acres were located in batture lands (U.S. Forest Service, 1992 and 1995). Considering the magnitude and duration of these impacts and the fact that nearly all of this acreage will still be considered forest land within 15 years after construction and that bears are generally sparse, one would not expect any adverse effects to population density of the bear. Completion of the project should not have any effects on travel corridors that enable bears to move considerable distances. During the planning phases of each item of work, measures will be taken to ensure that at least a 50-yard-wide forested corridor will remain at each construction site, where practical, after considering engineering, economic, environmental, and social concerns. This will ensure that bear movement is not affected.

35. Both daily and seasonal movements probably would be affected in occupied habitat by the construction works. Human activity would probably cause bears to avoid the area during work hours and also possibly during seasons when feeding and breeding movements occur. The construction season could last from June until December, depending upon weather conditions and flooding. Considering the short-term effects, the relatively small size of habitat affected, and the relatively sparse population of bears, this is not considered an adverse effect. In addition, borrow areas reverting to woods would provide seasonal feeding areas within approximately 2 years and dense cover areas within approximately 7 years (after Hamilton and Noble, 1975), except where excessive construction and grazing activities may stall forest development (U.S. Army Corps of Engineers, 1988).

36. The construction work will not affect strictly remote or secluded lands. This work will typically take place on and/or adjacent to existing levees that are usually open to primarily traffic for hunting and fishing and timber and farming practices. However, the bears' need for remoteness will be taken into account by avoiding the more secluded areas that provide feeding and cover to the extent practical.

37. While the project will affect a total of approximately 3,210 acres of the remaining bottom-land hardwoods in this portion of the Mississippi River Basin, an additional 2,873,604 acres may remain in the study area. Of this

total, 508,406 acres of woods remain in the batture lands within the Vicksburg District. In addition, 1,246,100 acres of oak-pine woods and 2,991,700 acres of oak-hickory woods were also present in this portion of the Basin in the early 1990's (U.S. Forest Service, 1991 and 1995). Hence, only about .05 percent of the woods in this study area will be affected over a period of approximately 25 years. This will be compensated for by either allowing the borrow sites to revert to woods or by planting trees in them following construction. Considering the data given above and the fact that the bear is generally sparsely populated and will make some use of various stages of woodland development, no adverse effects are expected to occur to the bear as a result of impacting woodlands in the study area.

38. Impacts to important bear foods should not be significant since not many of the important bear foods are usually present in the batture lands (lands between the levee and Mississippi River), and their abundance can vary significantly in various locations. Table 2 contains the plant species that are considered important to bears that will probably be impacted by the construction works (Mississippi Power and Light Company, 1973).

TABLE 2
IMPORTANT BOTTOM-LAND PLANTS IMPACTED

Crop Trees	Mid-Story	Understory	Planted
Sweet pecan	Dogwood	Dewberry	Hardwood plantations
Cypress	Wild Grape	Pokeweed	
	Poison Ivy	Greenbriar	
	Holly		

39. Sweet pecan is a scattered tree in riverfront hardwoods, and cypress trees are usually present in very low, poorly drained flats, deep sloughs, and swamps (Putnam, 1951). Geographic Information System mapping of the lands of the batture in the District is depicted in Table 3.

TABLE 3
BATTURE LAND COVER IN THE VICKSBURG DISTRICT

Cover Type	Area (1992 acreages)
Sycamore/Sweetgum/American Elm	110,667
Hackberry/American Elm/Ash	113,809
Cottonwood	70,110
Black Willow	77,909
Cottonwood/Black Willow	29,809

TABLE 3 (Cont)

Cover Type	Area (1992 acreages)
Sweetgum/Water Oaks	24,110
Pecan	17,158
Cypress/Tupelo Gum	12,349
Cypress	4,002
Nonforested Wetland	8,341
Overcup Oak/Bitter Pecan	3,280
Hackberry	3,131
Green Ash	2,958
Sweetgum	2,467
Sycamore	634
Oak	74
Overcup Oak	49
Tupelo Gum	639
Live Oak/Pecan	18
Live Oak	9
Scrub	29,528
Marsh	3,300
Levee	17,079
Sandbar	22,995
Cropland	120,175
Pasture, Old Field	13,118
Tree Plantations	35,224
Urban	4,734
Bare Soil	2,827
Total Acreage	730,503

40. Cottonwood plantations are present in portions of Louisiana and Mississippi. Dogwood and deciduous holly are usually present in appreciable numbers in the woods, and the abundance of the vines used by bears usually varies a great deal depending upon location. Pokeweed is usually present only in disturbed areas of the batture lands (Radford, Ahles, and Bell, 1968). These same foods will probably be present in borrow pits that have been allowed to revert to woods or have been reforested after construction works are complete. They are pioneer species and are the usual early stages of succession in hardwood bottoms (Braun, 1950). One could expect pokeweed and important berry-producing vines to be relatively abundant in borrow areas for a considerable period of time after construction. These sites should constitute good seasonal feeding areas for bears. The currently expected maximum extent of lands that could be impacted by this work are shown in Table 4.

TABLE 4
BATTURE LAND COVER IMPACTED BY CONSTRUCTION ACTIVITIES

Cover Type	Louisiana (acres)	Mississippi (acres)
Sycamore/Sweetgum/American Elm	370	860
Hackberry/American Elm/Ash	530	430
Cottonwood	600	550
Black Willow	410	190
Cottonwood/Black Willow	250	430
Sweetgum/Water Oak	270	260
Pecan	410	190
Cypress/Tupelo Gum	0	0
Cypress	10	10
Nonforested Wetland	110	40
Overcup Oak/Bitter Pecan	0	10
Hackberry	40	10
Green Ash	10	0
Sweetgum	30	0
Sycamore	10	10
Oak	0	0
Overcup Oak	0	0
Tupelo Gum	0	0
Live Oak/Pecan	0	0

TABLE 4 (Cont)

Cover Type	Louisiana (acres)	Mississippi (acres)
Live Oak	0	0
Scrub	200	120
Marsh	10	10
Sandbar	0	0
Cropland	1,520	410
Pasture, Old Field	70	230
Tree Plantations	110	460
Urban	10	0
Bare Soil	0	0
Open Water	250	60
Total Acreage	5,220	4,352 a/

a/ Includes 72 acres of nontyped woods.

41. By utilizing an innovative approach to berm construction and utilizing existing cleared riverside areas, this forested acreage shown in Table 4 may be reduced approximately 3,187 acres. This approach includes the use of hydraulic dredges (Figure 12) to construct the berms from material dredged from the Mississippi River (Figure 13). This berm is designed to use the existing landside seepage berm to obtain suitable material with which to construct the levee enlargement. After the levee enlargement is constructed, a retaining dike is constructed to a landside limit required for any enlargement of the seepage berm. By utilizing a hydraulic dredge, sand is pumped from the Mississippi River and placed in the berm to grade and section to replace the material excavated for the levee enlargement construction and whatever additional material is required for the enlargement of the seepage berm. The berm then has a soil cover placed on top to allow grass to grow for protection.

42. While some lands that provide dense cover for bears will be cleared by construction operations, areas that will revert to woodlands or be planted in

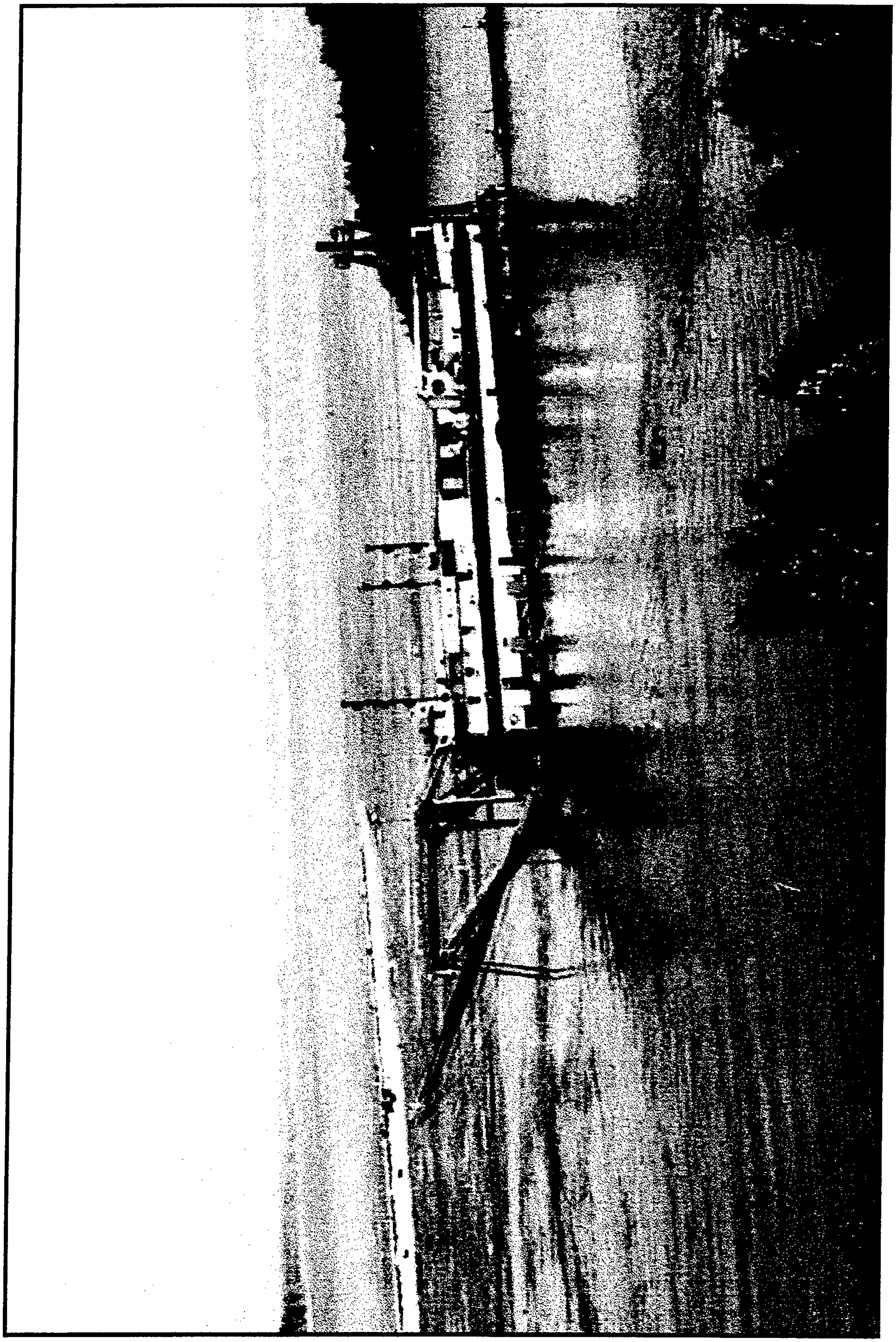
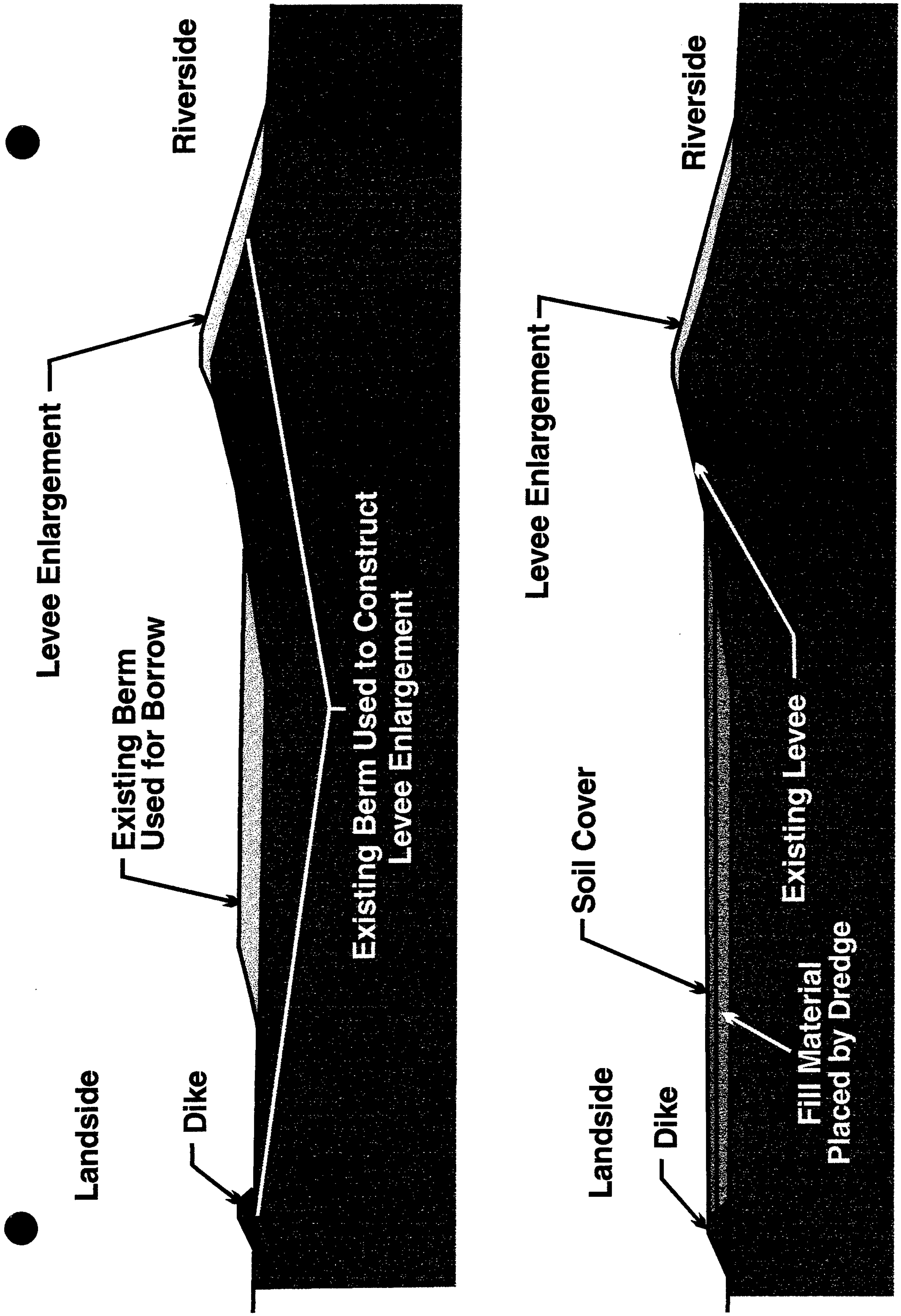


Figure 12



Landside
Riverside
Dike
Existing Berm
Used for Borrow
Levee Enlargement
Existing Berm Used to Construct
Levee Enlargement
Landside
Riverside
Dike
Soil Cover
Levee Enlargement
Fill Material
Placed by Dredge
Existing Levee

Figure 13

woods after construction should begin to provide some cover after about 2 years and should be providing some dense cover within about 7 years after construction. After this period of time, dense understories should occur in these areas for a few decades if left undisturbed (after Hamilton and Noble, 1975). Considering the small acreage that will be impacted each year, the large acreage of woods available in the District, and the number of bears that are thought to be present in the affected states, this impact on cover is not considered adverse.

43. The results of bear surveys will be used to avoid impacts to den trees and brush piles large enough to be used as dens. Any impacts on densites would not be considered significantly adverse. Although they are important, they probably do not limit the bear.

44. The construction works are not expected to have any adverse effects on the reproductive habits of the bear. A portion of the construction season occurs during times when some bears would be entering winter dens; however, bears would compensate for this by using dens located away from the construction sites. At other times (March-November timeframe), mating bears and females with cubs may avoid the construction sites at least during work hours. These slight effects are not considered adverse.

45. Considering the information on impacts to the bear and bear habitat discussed in previous paragraphs above, no adverse effects are predicted to occur to bear densities in the Vicksburg District as a result of the levee work of the MR&T project.

46. No black bear mortality is expected. Any bears occupying habitat that would be affected by construction activities would probably avoid the areas while humans were present. Hence, there should not be any conflicts between workers and bears at the various construction sites.

47. Completion of the mainline levees of the project is not likely to jeopardize the continued existence of the Louisiana black bear or result in the destruction of designated critical habitat for the species. The fact that only about .05 percent of the existing potential bear habitat will even be affected leads one to believe that the project will not affect the continued existence of the Louisiana black bear. Any lands that are used for borrow material on lands proposed as critical habitat will be carefully planned so that once construction measures are complete, they can either revert to forest lands or be planted with species of trees that are adapted to the site. This will ensure that the acreage of any critical habitat area(s) will not be adversely affected. These areas could provide some good quality seasonal feeding areas and good quality cover for a few decades and, if possible, will be located where it may be desirable to provide such areas. These effects to proposed or designated critical habitat are not considered adverse modifications.

48. The project should not restrict the recovery of the bear in the bottom area due to the small size of potential bear habitat that will be affected each year. In addition, there are only a small number of bears in the Vicksburg District and most of these probably occupy portions of the Tensas River Basin. There seems to be good potential for further expansion by the bear even with completion of the project.

CONCLUSIONS

49. Continued construction of the project as described in this assessment is likely to have minor or insignificant impacts on bear movements, foods, densites, and bear habitat including any proposed critical habitat. Measures will be included in the project to further reduce potential effects on the bear. At this time, it is concluded that completion of the flood control features of the main stem MR&T project will not likely have an adverse effect on the Louisiana black bear or its proposed critical habitat in the Vicksburg District.

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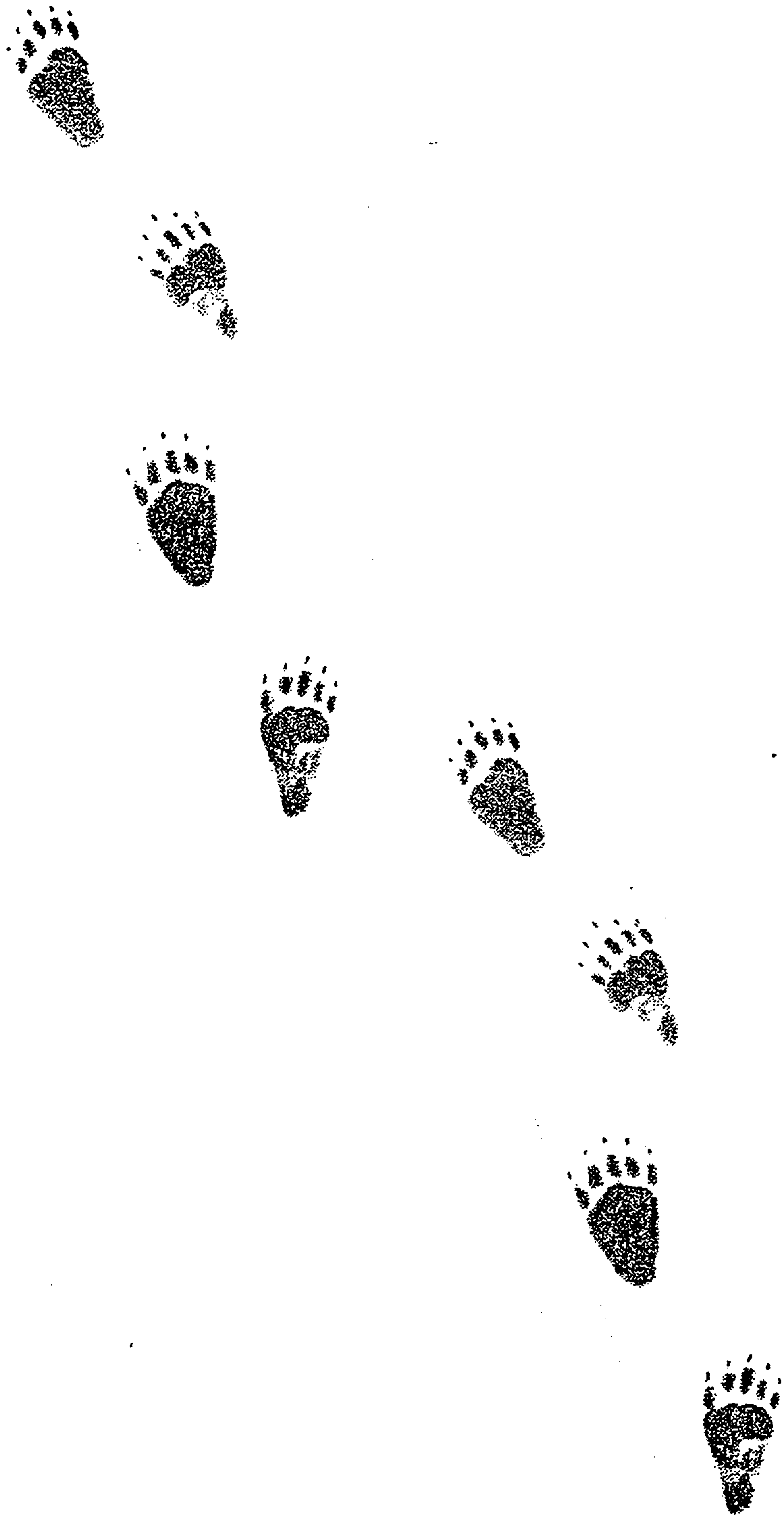

ATTACHMENT 4
PALLID STURGEON RECORDS
FOR STUDY AREA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Missouri River
Fish & Wildlife Management Assistance Office
1500 East Capitol Avenue
Bismarck, North Dakota 58501

MAY 2 8 1998

Mr. Jan Hoover
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, Mississippi 39180

Dear Mr. Hoover:

I've pulled down the records that are currently on the database and found that the most recent records from 1995 thru present have not been updated. I am waiting for that information at this time and will forward that when it arrives.

To give you a brief overview of the listing, the only column that may require an explanation is the column {CODE}. This is the abbreviation of the river where the capture occurred. The Atchafalaya River is abbreviated AT, Missouri - MO, Mississippi - MS, and so on. I printed one list with the primary location data and another corresponding list with relative information on length and weight data and tag information.

If you have any additional information requests, please don't hesitate to call Steve at (701) 250-4419.

Sincerely,

Steve Krentz

Steve Krentz
Fisheries Biologist
Missouri River FWMAO

Enclosure

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL

SPECIES	LOCATION	CODE	RM	STATE	DATE	YEAR	PERSON	TOWNSHIP	RANGE	COUNTY
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/11/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 8/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 8/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 8/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 8/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 8/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 8/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 8/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/11/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 7/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	3/30/94	94	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	4/23/93	94	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	4/23/93	94	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	4/23/93	94	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 5/93	93	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 5/93	93	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 5/93	93	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 5/93	93	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 7/93	93	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 7/93	93	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/93	93	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/ 2/94	94	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/ 2/94	94	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/ 2/94	94	G. CONSTANT			
'LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/ 2/94	94	G. CONSTANT			
LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/ 2/94	94	G. CONSTANT			
LS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/ 2/94	94	G. CONSTANT			

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL

SPECIES	LOCATION	CODE	RM	STATE	DATE	YEAR	PERSON	TOWNSHIP	RANGE	COUNTY
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/ 2/94	94	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	7/29/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	7/29/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	3/29/94	94	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/94	94	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/14/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/14/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/14/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/14/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/14/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/14/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/14/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	12/ 8/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	12/ 8/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/19/95	95	LDWF-BOBBY REED			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/19/95	95	LDWF-BOBBY REED			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	7/13/94	94	BOBBY REED			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/20/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/ 3/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/ 3/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/ 3/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/ 3/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/16/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/16/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	11/16/93	93	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	7/13/94	94	BOBBY REED			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	IN	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/94	94	G. CONSTANT	IN	5W	CONCORDIA

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL

5/27/98

SPECIES	LOCATION	CODE	RM	STATE	DATE	YEAR	PERSON	TOWNSHIP	RANGE	COUNTY
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/ 6/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/19/94	94	G. CONSTANT	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/18/90	90	COMMERCIAL FISHERMAN			ST. LANDRY PARISH
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/14/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/15/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/15/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/15/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/15/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/15/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/14/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/14/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/15/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/14/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	10/13/92	92	B. REED, EWING, ET AL.-LADWF			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	3/ 4/94	94	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/19/91	91	COMMERCIAL FISHERMEN			CONCORDIA PARISH
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/17/91	91	COMMERCIAL FISHERMEN			CONCORDIA PARISH
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/17/91	91	COMMERCIAL FISHERMEN			CONCORDIA PARISH
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/17/91	91	COMMERCIAL FISHERMEN			CONCORDIA PARISH
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/19/91	91	COMMERCIAL FISHERMEN			CONCORDIA PARISH
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	6/17/91	91	COMMERCIAL FISHERMEN			CONCORDIA PARISH
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	3/ 4/94	94	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	3/ 4/94	94	G. CONSTANT			
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	7/13/94	94	BOBBY REED			CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 7/93	93	GLENN CONSTANT, LSU FISHERIES	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 7/93	93	GLENN CONSTANT, LSU FISHERIES	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	4/23/93	93	GLENN CONSTANT, LSU FISHERIES	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	4/23/93	93	GLENN CONSTANT, LSU FISHERIES	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	4/23/93	93	GLENN CONSTANT, LSU FISHERIES	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 5/93	93	GLENN CONSTANT, LSU FISHERIES	1N	5W	CONCORDIA
PLS	ATCHAFALAYA RIVER- OLD RIVER CONTROL STR	AT	0.00	LA	5/ 7/93	93	GLENN CONSTANT, LSU FISHERIES	1N	5W	CONCORDIA
PLS	BIG SUNFLOWER RIVER	BS	35.00	MS	11/23/87	87	FISHERMAN- MHP	11N	5W	SHARKEY
PLS	MISSOURI RIVER	MO	458.00	MO		45	H. FISHER	57N	36W	ANDREW
PLS	MISSOURI RIVER- EASLEY	MO	166.90	MO	11/ 2/78	78	CARLSON ET AL.			BOONE
PLS	MISSOURI RIVER- EASELY	MO	169.00	MO	10/27/48	48	H. FISHER			BOONE

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL

SPECIES	LOCATION	CODE	RM	STATE	DATE	YEAR	PERSON	TOWNSHIP	RANGE	COUNTY
PLS	MISSOURI RIVER- BROWNSVILLE	MO	530.50	MO	10/ 5/78	78	CARLSON ET AL.			ATCHISON
PLS	MISSOURI RIVER- BROWNSVILLE	MO	459.60	MO	10/27/78	78	CARLSON ET AL.			ANDREW
PLS	MISSOURI RIVER- JEFFERSON CITY	MO	160.00	MO		89	CHARLES CALLAWAY- 4 FISH			COLE
PLS	MISSOURI RIVER	MO	227.00	MO		45	H. FISHER	51N	17W	CHARITON
PLS	MISSOURI RIVER- ROCHEPORT	MO	186.00	MO	6/ 3/63	63	W. PFLIEGER	48N	15W	BOONE
PLS	MISSOURI RIVER	MO	164.00	MO		72	MHP	46N	12W	BOONE
PLS	MISSOURI RIVER- ST. JOSEPH	MO	445.00	MO	2/22/92	92				BUCHANAN
PLS	MISSOURI RIVER	MO	324.00	MO	8/15/45	45	H. FISHER	51N	27W	LAFAYETTE
PLS	MISSOURI RIVER- KANSAS CITY	MO	367.00	MO		79	CARLSON ET AL.			CLAY
PLS	MISSOURI RIVER- ROCHEPORT	MO	185.00	MO	10/30/45	45	H. FISHER			BOONE
PLS	MISSOURI RIVER- ROCHEPORT	MO	186.00	MO	10/20/45	45	BAILEY AND CROSS			BOONE
PLS	MISSOURI RIVER- ROCHEPORT	MO	186.00	MO	2/24/46	46	BAILEY AND CROSS			BOONE
PLS	MISSOURI RIVER- ROCHEPORT	MO	186.00	MO	2/24/46	46	BAILEY AND CROSS			BOONE
PLS	MISSOURI RIVER- ST. CHARLES	MO	1.50	MO	6/28/78	78	CARLSON ET AL.			ST. LOUIS
PLS	MISSOURI RIVER- ST. JOSEPH	MO	444.00	MO		45	H. FISHER			BUCHANAN
PLS	MISSOURI RIVER- ST. JOSEPH	MO	445.00	MO		79	CARLSON ET AL.			BUCHANAN
PLS	MISSOURI RIVER- ST. CHARLES	MO	1.00	MO	7/12/44	44	BAILEY AND CROSS			ST. CHARLES
PLS	MISSISSIPPI RIVER	MS	665.00	AR		88	COMM. FISHERMAN- S. BARKLEY			PHILLIPS
PLS	MISSISSIPPI RIVER	MS	825.00	AR		63	COMMERCIAL FISHERMAN			MISSISSIPPI
PLS	MISSISSIPPI RIVER- CHESTER	MS	1,161.00	IL	4/15/92	92	JOHN BOOTH			RANDOLPH
PLS	MISSISSIPPI RIVER	MS	1,025.00	IL	3/20/72	72	P. KIMMEL	11S	3W	UNION
PLS	MISSISSIPPI RIVER	MS	982.00	IL	5/ 4/71	71	P. KIMMEL	11S	4W	UNION
PLS	MISSISSIPPI RIVER	MS	0.00	IL	11/ 1/91	91	COMMERCIAL FISHERMAN			
PLS	MISSISSIPPI RIVER- CHESTER	MS	1,161.00	IL		0	COMMERCIAL FISHERMAN			RANDOLPH
PLS	MISSISSIPPI RIVER- GRAFTON	MS	1,155.00	IL		4	FORBES AND RICHARDSON- 7 FISH			JERSEY
PLS	MISSISSIPPI RIVER	MS	1,027.00	IL		70	P. KIMMEL	11S	4W	UNION
PLS	MISSISSIPPI RIVER- CHESTER	MS	1,161.00	IL	4/15/91	91	COMMERCIAL FISHERMAN			RANDOLPH
PLS	MISSISSIPPI RIVER- CHESTER	MS	1,161.00	IL	10/30/91	91	COMMERCIAL FISHERMAN			RANDOLPH
PLS	MISSISSIPPI RIVER	MS	485.00	LA	11/ 2/68	68	O.D. KORN	10N	13E	EAST CARROLL
PLS	MISSISSIPPI RIVER- HENDERSON SWAMP	MS	234.00	LA	4/25/76	76	DR. H. HOESE (USL)			ST. LANDRY
PLS	MISSISSIPPI RIVER- NEW ORLEANS/METAIRE	MS	123.00	LA	6/12/73	73	DR. NEIL DOUGLAS- 2 FISH	12S	20E	ST. CHARLES
PLS	MISSISSIPPI RIVER- NEW ORLEANS/METAIRE	MS	126.00	LA	3/26/76	76	DR. NEIL DOUGLAS	12S	20E	ST. CHARLES
PLS	MISSISSIPPI RIVER- NEW ORLEANS	MS	120.00	LA		0	BAILEY AND CROSS (1882)			ORLEANS
PLS	MISSISSIPPI RIVER	MS	314.50	LA	4/ 7/85	85	GOUGH			CONCORDIA
PLS	MISSISSIPPI RIVER	MS	0.00	LA		85	DR. NEIL DOUGLAS			
LS	MISSISSIPPI RIVER- NEW ORLEANS	MS	120.00	LA	4/21/52	52	BAILEY AND CROSS			ORLEANS
LS	MISSISSIPPI RIVER	MS	'0.00	LA		77	DR. NEIL DOUGLAS			
LS	MISSISSIPPI RIVER	MS	0.00	LA		76	DR. NEIL DOUGLAS			
LS	MISSISSIPPI RIVER	MS	485.00	LA	11/ 2/68	68	O.D. KORN	10N	13E	EAST CARROLL
LS	MISSISSIPPI RIVER	MS	0.00	LA		68	DR. NEIL DOUGLAS			
LS	MISSISSIPPI RIVER- ATCHAFALAYA BASIN	MS	300.00	LA	5/10/54	54	LESTER BOUDREAUX			VERMILLION
LS	MISSISSIPPI RIVER- NEW ORLEANS	MS	120.00	LA	11/17/50	50	BAILEY AND CROSS			ORLEANS

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL up to 1994 5/28/98

CODE	RM	DATE	YEAR	FORKLENGTH	WEIGHT	COMMENTS	PIT TAG	TAG DATA
AT	0.00	10/11/93	93	862.00	2,699.00	COMMERCIAL FISHING	2519065	ANCHOR TAG 1005
AT	0.00	10/ 6/93	93	820.00	2,557.00	COMMERCIAL FISHING	1325266	ANCHOR TAG 1019
AT	0.00	10/ 6/93	93	760.00	1,705.00	COMMERCIAL FISHING	1877841	ANCHOR TAG 1006
AT	0.00	10/ 8/93	93	913.00	2,784.00	COMMERCIAL FISHING	1874801	ANCHOR TAG 1013
AT	0.00	10/ 8/93	93	868.00	2,813.00	COMMERCIAL FISHING	2514857	ANCHOR TAG 1024
AT	0.00	10/ 8/93	93	888.00	3,097.00	COMMERCIAL FISHING	1338324	ANCHOR TAG 1017
AT	0.00	10/ 8/93	93	773.00	2,017.00	COMMERCIAL FISHING	2279822	ANCHOR TAG 1020
AT	0.00	10/ 8/93	93	795.00	1,847.00	COMMERCIAL FISHING	1811827	ANCHOR TAG 1018
AT	0.00	10/ 8/93	93	675.00	909.00	COMMERCIAL FISHING	5781890	ANCHOR TAG 1022
AT	0.00	10/ 8/93	93	730.00	1,563.00	COMMERCIAL FISHING	1877529	ANCHOR TAG 1008
AT	0.00	10/11/93	93	849.00	2,642.00	COMMERCIAL FISHING		ANCHOR TAG 1048
AT	0.00	10/ 6/93	93	838.00	2,642.00	COMMERCIAL FISHING	1893610	ANCHOR TAG 1028
AT	0.00	10/20/93	93	892.00	2,869.00	COMMERCIAL FISHING	5114619	ANCHOR TAG 1025
AT	0.00	10/20/93	93	776.00	2,102.00	COMMERCIAL FISHING	5780078	ANCHOR TAG 1007
AT	0.00	10/20/93	93	857.00	2,642.00	COMMERCIAL FISHING	5259328	ANCHOR TAG 1015
AT	0.00	10/20/93	93	866.00	2,557.00	COMMERCIAL FISHING	1562543	ANCHOR TAG 1047
AT	0.00	10/20/93	93	854.00	2,443.00	COMMERCIAL FISHING	5781062	ANCHOR TAG 1003
AT	0.00	10/20/93	93	792.00	1,563.00	COMMERCIAL FISHING	2327802	ANCHOR TAG 1014
AT	0.00	10/20/93	93	827.00	1,989.00	COMMERCIAL FISHING	1879029	ANCHOR TAG 1023
AT	0.00	10/20/93	93	792.00	1,648.00	COMMERCIAL FISHING	1784880	ANCHOR TAG 1004
AT	0.00	10/20/93	93	737.00	1,364.00	COMMERCIAL FISHING	1812039	ANCHOR TAG 1010
AT	0.00	10/20/93	93	827.00	2,159.00	COMMERCIAL FISHING	1563355	ANCHOR TAG 1021
AT	0.00	10/20/93	93	892.00	2,443.00	COMMERCIAL FISHING	1513869	ANCHOR TAG 1040
AT	0.00	10/20/93	93	830.00	2,188.00	COMMERCIAL FISHING	5607277	ANCHOR TAG 1011
AT	0.00	5/ 7/93	93	921.00	3,610.00	COMMERCIAL FISHING	1788375	
AT	0.00	3/30/94	94	891.00	3,523.00	COMMERCIAL FISHING	6114071	ANCHOR TAG 1030
AT	0.00	4/23/93	94	925.00	4,400.00	COMMERCIAL FISHING	5520324	
AT	0.00	4/23/93	94	1,003.00	6,300.00	COMMERCIAL FISHING	5607881	
AT	0.00	4/23/93	94	840.00	2,610.00	COMMERCIAL FISHING	2093620	
AT	0.00	5/ 5/93	93	820.00	2,840.00	COMMERCIAL FISHING	1342068	
AT	0.00	5/ 5/93	93	870.00	2,930.00	COMMERCIAL FISHING		
AT	0.00	5/ 5/93	93	697.00	1,023.00	COMMERCIAL FISHING	2093820	
AT	0.00	5/ 5/93	93	770.00	2,045.00	COMMERCIAL FISHING	5280595	
AT	0.00	5/ 7/93	93	764.00	2,040.00	COMMERCIAL FISHING	2275638	
AT	0.00	5/ 7/93	93	866.00	3,290.00	COMMERCIAL FISHING	5352612	
AT	0.00	10/ 6/93	93	813.00	2,330.00	COMMERCIAL FISHING	5781638	ANCHOR TAG 1001
AT	0.00	6/ 2/94	94	740.00	1,750.00	COMMERCIAL FISHING	5283823	ANCHOR TAG 1034
AT	0.00	6/ 2/94	94	809.00	2,301.00	COMMERCIAL FISHING	5870304	ANCHOR TAG 1029
AT	0.00	6/ 2/94	94	741.00	0.00	COMMERCIAL FISHING	2000860	ANCHOR TAG 1198
AT	0.00	6/ 2/94	94	767.00	2,000.00	COMMERCIAL FISHING	1889002	ANCHOR TAG 1197
AT	0.00	6/ 2/94	94	771.00	2,045.00	COMMERCIAL FISHING	5819067	ANCHOR TAG 1027
AT	0.00	6/ 2/94	94	921.00	3,636.00	COMMERCIAL FISHING	1535259	ANCHOR TAG 1045

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL up to 1994

CODE	RM	DATE	YEAR	FORKLENGTH	WEIGHT	COMMENTS	PIT TAG	TAG DATA
AT	0.00	6/ 2/94	94	721.00	1,591.00	COMMERCIAL FISHING	1556076	ANCHOR TAG 1037
AT	0.00	7/29/93	93	733.00	1,700.00	COMMERCIAL FISHING		
AT	0.00	7/29/93	93	838.00	3,090.00	COMMERCIAL FISHING		
AT	0.00	10/ 6/93	93	991.00	3,807.00	COMMERCIAL FISHING	1872285	ANCHOR TAG 1049
AT	0.00	3/29/94	94	980.00	4,034.00	COMMERCIAL FISHING	6113831	ANCHOR TAG 1032
AT	0.00	10/20/94	94	872.00	3,182.00		1317039	ANCHOR TAG 1009
AT	0.00	10/19/94	94	840.00	2,818.00		1567771	ANCHOR TAG 1184
AT	0.00	10/19/94	94	830.00	2,318.00		2054846	ANCHOR TAG 1186
AT	0.00	10/19/94	94	678.00	1,045.00	HYBRID		
AT	0.00	10/19/94	94	628.00	863.00	HYBRID		
AT	0.00	10/19/94	94	629.00	954.00	HYBRID		
AT	0.00	10/19/94	94	816.00	2,818.00	HYBRID		
AT	0.00	10/20/94	94	645.00	1,091.00	HYBRID		
AT	0.00	10/20/94	94	854.00	3,000.00		2515093	
AT	0.00	10/20/94	94	824.00	3,454.00	HYBRID		ANCHOR TAG 1180
AT	0.00	10/20/94	94	873.00	3,182.00			ANCHOR TAG 1188
AT	0.00	10/19/94	94	847.00	2,727.00		5524332	ANCHOR TAG 1031
AT	0.00	11/14/94	94	980.00	4,858.00		5602305	ANCHOR TAG 1190
AT	0.00	11/14/94	94	1,004.00	6,220.00		6227289	ANCHOR TAG 1185
AT	0.00	11/14/94	94	850.00	3,041.00			ANCHOR TAG 1182
AT	0.00	11/14/94	94	775.00	1,680.00		1788067	ANCHOR TAG 1178
AT	0.00	11/14/94	94	813.00	2,406.00		5334614	ANCHOR TAG 1196
AT	0.00	11/14/94	94	814.00	2,815.00		1789371	ANCHOR TAG 1181
AT	0.00	11/14/94	94	895.00	3,450.00		1816884	ANCHOR TAG 1192
AT	0.00	12/ 8/94	94	820.00	2,361.00		1819308	ANCHOR TAG 1042
AT	0.00	12/ 8/94	94	675.00	1,180.00	HYBRID	2001023	ANCHOR TAG 1179
AT	0.00	5/19/95	95	871.00	3,700.00	CAUGHT BY COMMERCIAL FISHERMAN	002057863	
AT	0.00	5/19/95	95	770.00	2,300.00	CAUGHT BY COMMERCIAL FISHERMAN	001809568	
AT	0.00	10/20/93	93	773.00	1,847.00	COMMERCIAL FISHING	5870880	ANCHOR TAG 1039
AT	0.00	7/13/94	94	865.00	2,950.00		002059271	01326 ORANGE
AT	0.00	10/20/93	93	790.00	1,619.00	COMMERCIAL FISHING		
AT	0.00	10/20/93	93	809.00	1,989.00	COMMERCIAL FISHING	1840366	
AT	0.00	11/ 3/93	93	705.00	1,400.00	COMMERCIAL FISHING		ANCHOR TAG 4851
AT	0.00	11/ 3/93	93	775.00	1,900.00	COMMERCIAL FISHING	6112379	ANCHOR TAG 1044
AT	0.00	11/ 3/93	93	630.00	1,100.00	COMMERCIAL FISHING		ANCHOR TAG 4852
AT	0.00	11/ 3/93	93	762.00	1,775.00	COMMERCIAL FISHING	5801256	ANCHOR TAG 1035
AT	0.00	11/16/93	93	825.00	2,700.00	COMMERCIAL FISHING		
AT	0.00	11/16/93	93	946.00	3,700.00	COMMERCIAL FISHING		
AT	0.00	11/16/93	93	710.00	1,900.00	COMMERCIAL FISHING		
AT	0.00	7/13/94	94	960.00	4,650.00	STRECH MARKS AND SWOLLEN VENT	001339806	01332 ORANGE
AT	0.00	10/19/94	94	947.00	3,682.00		2007831	ANCHOR TAG 1046
AT	0.00	10/ 6/94	94	735.00	1,545.00	HYBRID		

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL up to 1994

5/28/98

CODE	RM	DATE	YEAR	FORKLENGTH	WEIGHT	COMMENTS	PIT TAG	TAG DATA
AT	0.00	10/ 6/94	94	885.00	2,955.00		6112563	ANCHOR TAG 1194
AT	0.00	10/ 6/94	94	820.00	2,318.00		5283883	ANCHOR TAG 1200
AT	0.00	10/ 6/94	94	791.00	2,409.00		1315051	ANCHOR TAG 1193
AT	0.00	10/ 6/94	94	755.00	1,909.00		1892266	ANCHOR TAG 1176
AT	0.00	10/ 6/94	94	673.00	1,364.00	HYBRID	1517529	ANCHOR TAG 1189
AT	0.00	10/19/94	94	784.00	2,045.00	HYBRID	2121058	ANCHOR TAG 1191
AT	0.00	10/19/94	94	718.00	1,500.00	HYBRID		
AT	0.00	10/19/94	94	875.00	3,136.00		2347008	ANCHOR TAG 1195
AT	0.00	10/19/94	94	842.00	2,227.00		1788884	ANCHOR TAG 1050
AT	0.00	6/18/90	90	0.00	12,474.00			
AT	0.00	10/14/92	92	816.00	3,100.00	DISCHARGE 45,000 CFS; RIPE; FOUND DEAD		
AT	0.00	10/15/92	92	785.00	3,100.00	DISCHARGE 42,000 CFS	001-638-776	FLOY TAG ORANGE 04982
AT	0.00	10/15/92	92	842.00	2,900.00	DISCHARGE 42,000 CFS	002-091-094	FLOY TAG ORANGE 04983
AT	0.00	10/15/92	92	885.00	3,300.00	DISCHARGE 42,000 CFS	001-845-793	FLOY TAG ORANGE 04984
AT	0.00	10/15/92	92	774.00	2,000.00	DISCHARGE 42,000 CFS	002-094-546	FLOY TAG ORANGE 04991
AT	0.00	10/15/92	92	772.00	2,250.00	DISCHARGE 42,000 CFS	001-840-613	FLOY TAG ORANGE 04993
AT	0.00	10/14/92	92	620.00	820.00	DISCHARGE 45,000 CFS	002-094-002	FLOY TAG ORANGE 04995
AT	0.00	10/14/92	92	850.00	2,600.00	DISCHARGE 45,000 CFS	001-378-116	FLOY TAG ORANGE 04998
AT	0.00	10/15/92	92	668.00	1,000.00	DISCHARGE 42,000 CFS	002-381-112	FLOY TAG ORANGE 04981
AT	0.00	10/14/92	92	883.00	2,825.00	DISCHARGE 45,000 CFS	001-805-782	FLOY TAG ORANGE 04999
AT	0.00	10/13/92	92	760.00	1,500.00	DISCHARGE 27,000 CFS; RECAPTURED 10/20/92	002-381-832	FLOY TAG ORANGE 05000
AT	0.00	3/ 4/94	94	698.00	1,300.00	COMMERCIAL FISHING, HYBRID		ANCHOR TAG 1043
AT	0.00	6/19/91	91	865.00	4,200.00	BLACK AND WHITE EGGS PRESENT		
AT	0.00	6/17/91	91	910.00	4,000.00	MATURING (1 YEAR AWAY) STAGE 2		
AT	0.00	6/17/91	91	601.00	800.00	STAGE 2		
AT	0.00	6/17/91	91	705.00	1,950.00	STAGE 1		
AT	0.00	6/19/91	91	738.00	1,950.00			
AT	0.00	6/17/91	91	853.00	3,864.00	GRAVID- EGGS WHITE AND NOT FULLY DEVELOPED		
AT	0.00	3/ 4/94	94	0.00	2,727.00	COMMERCIAL FISHING, HYBRID		ANCHOR TAG 1033
AT	0.00	3/ 4/94	94	815.00	2,699.00	COMMERCIAL FISHING		ANCHOR TAG 1041
AT	0.00	7/13/94	94	875.00	3,050.00	ONE OF TWENTY PALLIDS CAUGHT BY COMMERCIAL FISHERMAN	001814028	01350 ORANGE
AT	0.00	5/ 7/93	93	764.00	2,040.00	POSSIBLE HYBRID, BELLY SCALES PRESENT, VELOCITY MISLEADING	002-275-638	
AT	0.00	5/ 7/93	93	921.00	3,610.00	FISH CAUGHT IN LOW SILL CHANNEL, UNDETERMINED SEX	001-788-375	68 KHZ, CODE 249
AT	0.00	4/23/93	93	925.00	4,400.00	VEL. MISLEADING MOVING AWAY FROM LENTIC ENVIRON, RIPE FEMALE	005-520-324	72 KHZ, CODE 285
AT	0.00	4/23/93	93	1,003.00	6,300.00	H20 VELOCITY MISLEADING, FISH MOVING AWAY FROM LENTIC ENVIRO	005-607-881	72 KHZ, CODE 258
AT	0.00	4/23/93	93	840.00	2,610.00	H20 VELOCITY MISLEADING, FISH MOVING AWAY FROM LENTIC ENVIRO	002-093-620	0001-344-028
AT	0.00	5/ 5/93	93	820.00	2,840.00	H20 VELOCITY MISLEADING, FISH MOVING AWAY FROM LENTIC ENVIRO	001-342-068	73 KHZ, CODE 376
AT	0.00	5/ 7/93	93	866.00	3,290.00	FISH CAUGHT IN LOW SILL CHANNEL, UNDETERMINED SEX	005-352-612	
BS	35.00	11/23/87	87	0.00	760.00			
MO	458.00		45	0.00	0.00			
MO	166.90	11/ 2/78	78	480.00	355.00			
MO	169.00	10/27/48	48	813.00	1,860.00			

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL up to 1994

:ODE	RM	DATE	YEAR	FORKLENGTH	WEIGHT	COMMENTS	PIT_TAG	TAG_DATA
MO	530.50	10/ 5/78	78	895.00	2,760.00			
MO	459.60	10/27/78	78	538.00	550.00			
MO	160.00		89	0.00	0.00			
MO	227.00		45	0.00	0.00			
MO	186.00	6/ 3/63	63	0.00	0.00			
MO	164.00		72	0.00	0.00			
MO	445.00	2/22/92	92	1,060.00	5,330.00	GENETICS SAMPLE DPR-P1	7F7F06683D	
MO	324.00	8/15/45	45	0.00	0.00			
MO	367.00		79	0.00	0.00			
MO	185.00	10/30/45	45	0.00	0.00			
MO	186.00	10/20/45	45	576.00	0.00			
MO	186.00	2/24/46	46	352.00	0.00			
MO	186.00	2/24/46	46	430.00	0.00			
MO	1.50	6/28/78	78	680.00	1,390.00			
MO	444.00		45	0.00	0.00			
MO	445.00		79	0.00	0.00			
MO	1.00	7/12/44	44	0.00	0.00			
MS	665.00		88	1,025.00	3,750.00			
MS	825.00		63	0.00	9,143.00			
MS	1,161.00	4/15/92	92	736.00	2,050.00	SPAWNED 1992	7F7D434651	
MS	1,025.00	3/20/72	72	0.00	0.00			
MS	982.00	5/ 4/71	71	0.00	0.00			
MS	0.00	11/ 1/91	91	0.00	2,000.00	BLIND PONY HATCHERY	7F7F056465	
MS	1,161.00		0	883.00	3,632.00	SPAWNED 1992	7F7F066200	
MS	1,155.00		4	0.00	0.00			
MS	1,027.00		70	0.00	0.00			
MS	1,161.00	4/15/91	91	763.00	1,930.00	GENETICS SAMPLE DMR-P1A, SPAWNED 1992, OUTER BARBEL BROKEN	7F7F065244	
MS	1,161.00	10/30/91	91	0.00	2,156.00	GENETICS SAMPLE DMR-P2, NO TAIL	7F7F056465	
MS	485.00	11/ 2/68	68	0.00	700.00			
MS	234.00	4/25/76	76	0.00	0.00	USL COLLECTION #5492; ATCHAFALAYA RM 53		
MS	123.00	6/12/73	73	0.00	0.00			
MS	126.00	3/26/76	76	0.00	0.00			
MS	120.00		0	0.00	0.00			
MS	314.50	4/ 7/85	85	0.00	0.00			
MS	0.00		85	0.00	0.00	1 FROM OLD RIVER CONTROL STRUCTURE		
MS	120.00	4/21/52	52	0.00	0.00			
MS	0.00		77	0.00	0.00	1 FROM OLD RIVER CONTROL STRUCTURE		
MS	0.00		76	0.00	0.00	1 FROM OLD RIVER CONTROL STRUCTURE		
MS	485.00	11/ 2/68	68	0.00	1,400.00			
MS	0.00		68	0.00	0.00	2 FROM OLD RIVER CONTROL STRUCTURE		
MS	300.00	5/10/54	54	0.00	0.00			
MS	120.00	11/17/50	50	0.00	0.00			

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL up to 1994

CODE	RM	DATE	YEAR	FORKLENGTH	WEIGHT	COMMENTS	PIT_TAG	TAG_DATA
MS	100.00	10/19/77	77	0.00	0.00			
MS	229.00	5/11/87	87	0.00	0.00	USL COLLECTION		
MS	846.00		0	744.00	1,816.00	GENETICS SAMPLE DOR-P2	7F7D43452F	
MS	846.00	3/ 9/92	92	888.00	4,200.00	SPAWNED 1992	7F7D353F2C	
MS	1,067.50	10/18/78	78	635.00	970.00			
MS	1,057.00		81	0.00	0.00			
MS	1,146.00		44	0.00	0.00			
MS	951.50	5/23/79	79	623.00	1,390.00			
MS	846.00		0	777.00	2,043.00	GENETICS SAMPLE DOR-P1, SPAWNED 1992	7F7D380727	
MS	400.00		73	0.00	0.00			
MS	410.00	8/18/80	80	0.00	0.00			
MS	408.20	12/13/72	72	0.00	0.00			
MS	880.00		90	0.00	0.00			
MS	832.00	10/27/90	90	0.00	0.00			
MS	872.00		90	0.00	0.00			
OH	2.80	5/23/79	79	743.00	1,810.00			
OH	2.80	5/23/79	79	0.00	2,360.00			
OH	13.70	1/15/78	78	759.00	1,830.00			
SF	35.00		66	0.00	0.00			

Pallid sturgeon capture records for States of LA, MS, AR, TN, MO, IL

5/27/9?

PECIES	LOCATION	CODE	RM	STATE	DATE	YEAR	PERSON	TOWNSHIP	RANGE	COUNTY
LS	MISSISSIPPI RIVER- LITTLE BAYOU PIERRE	MS	100.00	LA	10/19/77	77	DR. NEIL DOUGLAS	11S	20E	ST. BERNARD
LS	MISSISSIPPI RIVER- I-10 BRIDGE	MS	229.00	LA	5/11/87	87	DR. BRUCE THOMPSON (LSU)			E. BATON ROUGE
LS	MISSISSIPPI RIVER- CARUTHERSVILLE	MS	846.00	MO		0				PEMISCOT
LS	MISSISSIPPI RIVER- CARUTHERSVILLE	MS	846.00	MO	3/9/92	92	BYRON MANN			PEMISCOT
LS	MISSISSIPPI RIVER- ST. GENEVIEVE	MS	1,067.50	MO	10/18/78	78	CARLSON ET AL.			ST. GENEVIEVE
LS	MISSISSIPPI RIVER	MS	1,057.00	MO		81	T. GRACE	37N	11E	PERRY
LS	MISSISSIPPI RIVER	MS	1,146.00	MO		44	BARNICKOL AND STARRETT	47N	8E	ST. CHARLES
LS	MISSISSIPPI RIVER- CAIRO	MS	951.50	MO	5/23/79	79	CARLSON ET AL.			MISSISSIPPI
LS	MISSISSIPPI RIVER- CARUTHERSVILLE	MS	846.00	MO		0				PEMISCOT
LS	MISSISSIPPI RIVER	MS	400.00	MS		73	J. STEWART AND B. MISSO			CLAIBORNE
LS	MISSISSIPPI RIVER	MS	410.00	MS	8/18/80	80	W.F. MCCONNEL			CLAIBORNE
LS	MISSISSIPPI RIVER	MS	408.20	MS	12/13/72	72	L.M. CAMPBELL	12N	1E	CLAIBORNE
LS	MISSISSIPPI RIVER- TIPTONVILLE	MS	880.00	TN		90	COMM. FISHERMAN- RONNIE CAPPS			LAKE
LS	MISSISSIPPI RIVER- HELOISE	MS	832.00	TN	10/27/90	90	COMM. FISHERMAN- RONNIE CAPPS			DYER
LS	MISSISSIPPI RIVER- RIDGLEY	MS	872.00	TN		90	COMM. FISHERMAN- RONNIE CAPPS			LAKE
LS	OHIO RIVER- CAIRO	OH	2.80	MO	5/23/79	79	CARLSON ET AL.			MISSISSIPPI
LS	OHIO RIVER- CAIRO	OH	2.80	MO	5/23/79	79	CARLSON ET AL.			MISSISSIPPI
LS	OHIO RIVER- CAIRO	OH	13.70	MO	1/15/78	78	CARLSON ET AL.			MISSISSIPPI
LS	ST. FRANCIS RIVER- MISSISSIPPI RM 725	SF	35.00	AR		66	COMM. FISHERMAN- S. BARKLEY			ST. FRANCIS

APPENDIX 12
NEOTROPICAL MIGRANTS

ABSTRACT

A review of Neotropical migratory bird species composition and habitat availability was used to assess the impacts of two structural plans proposed to control seepage and enlarge the mainline Mississippi River Levees within the U.S. Army Corps of Engineers, Memphis, Vicksburg, and New Orleans Districts. A no-action and nonstructural alternative were considered and deemed nonviable during the planning process.

The recommended plan would result in the conversion of approximately 19,000 acres of land to project features, and would include reforestation of 3,041 acres of drained borrow pits and 5,863 acres of frequently flooded agricultural lands to offset project impacts. Project features would primarily consist of borrow areas, seepage control measures, and enlarged levees. Land use changes would primarily occur in cropland and forested areas.

An estimated 184 species of Neotropical migratory birds, representing 33 families, are known to regularly occupy or use the project area. This list includes 14 species considered to be of management concern. The primary impact would include the conversion of breeding, resting, and foraging habitat to project features. The decrease in forested habitat would be the greatest impact to Neotropical migrants. Based on the environmental design measures and reforestation efforts utilized in the recommended plan to minimize adverse impacts, no significant adverse impact to Neotropical migratory birds would be expected to result from the proposed project.

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 12
NEOTROPICAL MIGRANTS

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APPENDIX 12
NEOTROPICAL MIGRANTS

INTRODUCTION

1. This report evaluates the potential effects of proposed Mississippi River Mainline levee enlargement and seepage control on Neotropical migratory birds which are known to utilize the project area. Pertinent biological and ecological data are based on both published literature, communication with experts, and findings of U.S. Army Corps of Engineers investigations. The proposed construction is part of the Mississippi River and Tributaries Project authorized by the Flood Control Act of 1928.

BACKGROUND

2. Ornithology in North America has developed not only through the contributions of professionals, but enormous amounts of information on distribution, abundance, and ecology have been provided by amateurs. This indicates the significant public interest in the science and hobby of birding. In recent years, reports of long-term population declines in Neotropical migratory bird populations have caused justifiable concern and spurred numerous theories as to the cause of these declines.

3. The exact definition of Neotropical migratory birds and affiliate species has been debated by numerous authors. The definition of a Neotropical migratory bird presented by DeGraff and Rappole (1995) includes those species that breed in the Nearctic faunal region and winter in the Neotropics. This report will address species occurring within the study boundaries from the list provided by the research working group of the Partners in Flight program (Finch and Martin, 1991). Their list identifies 255 species of land birds "generally recognized" as Neotropical migrants.

4. A number of authors have proposed that tropical deforestation has caused Neotropical migratory bird population declines, presumably by reducing adult survival (Terborgh, 1989; Askins, et al., 1990). Others have hypothesized that habitat degradation where these migrants breed in North America has caused the observed population declines, presumably by decreasing reproductive success (Sherry and Holmes, 1989). Habitat degradation in North America has been attributed to the loss of breeding-ground habitat, habitat fragmentation, successional changes of breeding-ground habitat due to timber harvest practices, resting or stopover habitat alteration (U.S. Fish and Wildlife Service, 1987; Robbins, 1992; Litwin and Smith, 1992; Howe, et al., 1989; Rappole, et al., 1983). Even in fairly stable North American landscapes where the proportions of forest, agricultural land, and suburban development have remained essentially constant for decades, subtle changes have greatly altered conditions to the benefit of some species and the detriment of others (Terborgh 1989). The consensus seems to be that both habitat degradation in North America and tropical deforestation have played a role in Neotropical migratory bird population declines.

5. There still remains some scepticism among scientists that the reported population declines, especially of forest-dwelling migrants, represent actual threats to Neotropical migrant species (Hutto, 1988). The apparent overall population declines in certain species of migrants may be the result of regional population fluctuations related to regional breeding conditions rather than to any population-wide phenomenon (James, et al., 1992). Knowledge of year-round demographic processes and their ecological bases is needed to pinpoint the cause(s) of declining long-distance migrant populations (Sherry and Holmes, 1989).

OBJECTIVES

6. This report presents information on species composition and habitat availability to Neotropical migratory birds within the study boundaries of the Mississippi River Mainline levee enlargement and seepage control project in the lower Mississippi Valley and discusses changes that would occur due to construction. This report will also discuss and evaluate the various alternatives of avoiding, minimizing, and compensating unavoidable adverse impacts to Neotropical birds during the construction of the remaining levee items.

PROJECT AREA

7. The project area includes all lands and water between the Mississippi River levees, including 3,000 feet landside, beginning at Cape Girardeau, Missouri, and extending downstream to Head of Passes, Louisiana (see Project Report). There are approximately 980 river miles within the study boundaries and approximately 2,100,000 acres of land and 500,000 acres of water. For the purposes of this appendix, individual construction items or acreage within each District will not be identified.

8. The project area has been classified into 20 categories which include a wetland and nonwetland classification of the following land use types--cropland, forested, herbaceous, levee, marsh, open water, pasture/old field, scrub/shrub, tree plantation, and urban. Land cover maps were derived from photointerpretation of uncontrolled false-color infrared aerial photographs flown between 1992 and 1997. These maps were used to estimate land use changes due to project features and develop measures to avoid and minimize impacts to significant resources.

ALTERNATIVES

NO-ACTION ALTERNATIVE

9. No new construction; i.e., seepage control, frontal protection, and levee height increases, only normal maintenance, repair, and replacement would be done. Thus, existing levees, berms, and floodways would remain in place as the only flood protection. Therefore, the threat of catastrophic flooding would continue. Local levee boards and the Corps would continue to expend funds in flood-fight efforts, including temporarily raising levee reaches and sandbagging sand boils.

10. As part of a report prepared in FY 97 at the direction of the U.S. Senate, limited studies were conducted to determine the expected damages from crevasses in the Mississippi River mainline levees at Mayersville, Mississippi, and Lake Providence, Louisiana. These investigations provide an indication of how catastrophic the impacts from a levee failure would be to the rest of the study area.

11. Crevasses near the small towns of Mayersville and Lake Providence, located in the central Delta region, would cause catastrophic flooding over approximately 25,000 square miles, directly affecting approximately 114,000 people, 40,000 residences, and 1,600 businesses in 12 counties and parishes along the river. Plate 47 (Appendix 4) shows the flood plain area that would be inundated with a levee failure at Lake Providence, Louisiana, and Plate 48 (Appendix 4) illustrates the alluvial area that would be inundated with a levee crevasse at Mayersville, Mississippi. Results of damage analyses indicate levee crevasses could potentially cause direct flood damages approaching $5.0 billion--almost $2.0 billion in the areas along the east bank of the Mississippi River and $3.0 billion on the west bank.

12. A summary of flood damages/losses is depicted in Table 12-1.

TABLE 12-1
LEVEE CREVASSE AT MAYERSVILLE, MISSISSIPPI,
AND LAKE PROVIDENCE, LOUISIANA
SUMMARY OF FLOOD DAMAGES/LOSSES
($000)

Damage/Loss Category	Lake Providence Levee Crevasse	Mayersville Levee Crevasse	Total Damages/Losses
Structure Damages	1,139,746	426,264	1,566,010
Business Losses	1,031,039	569,989	1,601,028
Public Utilities	79,782	29,838	109,620
Road and Bridge Damages	22,809	8,365	31,174
Agricultural Losses	447,144	468,247	915,391
Noncrop Damages	60,823	37,846	98,669
Traffic Rerouting	72,162	3,604	75,766
Emergency Costs	50,403	39,840	90,243
Evacuation and Subsistence Costs	26,821	21,200	48,021
Reoccupation Costs	42,471	33,570	76,041
TOTALS	2,973,200	1,638,763	4,611,963

13. Since the no-action alternative would not provide protection from the Project Design Flood (PDF) and is unacceptable to Congress and the general public and thus unimplementable, no further consideration was given to the no-action option.

PLAN 1 - NONSTRUCTURAL ALTERNATIVE

14. Plan 1 represents a nonstructural option to structural flood damage reduction. Basically, only two types of practicable nonstructural measures for flood protection exist--those which reduce existing damages and those which reimburse for existing damages and reduce future damage potential. Those nonstructural measures which reduce damages were not applicable to levee overtopping and catastrophic levee failure. The nonstructural measure which

compensates or reimburses for existing damages that was addressed was purchasing easements in lieu of providing flood protection from the PDF. Existing levee protection would be maintained as in the no-action alternative. However, should the levee be overtopped and catastrophic levee failure occur, the levee would not be reconstructed.

15. Nonstructural alternatives such as acquisition of flowage easements can be utilized only if they further a project purpose or there is some legal obligation for them. Flowage easements were considered as a substitute for provision of PDF protection through levee raising. Such an alternative would not accomplish the congressionally mandated project purpose to provide a prescribed level of flood protection. In view of this and considering the prohibitive implementation and continuing costs and certain public unacceptability, a nonstructural plan would not be implementable. It was given no additional consideration.

STRUCTURAL ALTERNATIVES

16. Three structural alternatives were addressed in the preliminary screening-- Plan 2, landside borrow; Plan 3, traditional method (riverside borrow); and Plan 4, environmental design (avoid and minimize) to construct levee enlargement and seepage control.

Plan 2 - Landside Borrow

17. This alternative presumes continuing construction of levee enlargement and raising, seepage control, and frontal protection. All borrow material would be obtained from landside of the levee. Three landside borrow schemes were investigated:

a. Plan 2A - Traditional landside borrow.

(1) Plan 2A consists of purchasing rights-of-way for traditional rectangular borrow areas 8 to 10 feet deep in a band 2,000 to 3,000 feet from the landside toe of the levee where feasible (see Plate 49, Appendix 4). A minimum distance of 2,000 feet from the landside levee toe to the closest borrow area is required to prevent underseepage problems and a maximum of 3,000 feet from the landside levee toe was used as the outer limit on the distance to haul borrow for levee and berm construction.

(2) Suitable material would be excavated and used to enlarge the levee as shown on Plate 49 (Appendix 4) or to construct berms. The landside rights-of-way would be expensive. The extended borrow haul distance would also increase costs.

(3) Water quality in the landside borrow areas would likely be poor due to runoff from adjacent agricultural fields. The runoff would carry high loads of suspended sediments, nutrients, and organochlorine pesticides. Existing landside borrow areas have high levels of DDE. Fish tissue levels of DDE from samples acquired as a part of these studies approach the FDA action levels for fish consumption and are two orders of magnitude above the no observable effects level for these pesticides.

b. Plan 2B - Traditional landside borrow with forested buffer.

(1) This alternative consists of a deep (average 8 feet) borrow area which would be protected by a forested buffer zone approximately equal in area to the borrow, with a protective berm around the outside of the buffer to prevent chemicals from entering the borrow area (see Plate 50, Appendix 4). As in Plan 2A, the required location for the borrow area is 2,000 to 3,000 feet landside of the levee toe.

(2) Plate 50 (Appendix 4) shows the excavated borrow area with the material used to enlarge the levee. The forested buffer area and protective dike are shown on the borrow area periphery. This design would isolate the borrow from the local drainage which carries pesticides, thereby improving water quality. However, this requires additional cost for engineering and design and lands and damages.

c. Plan 2C - Landside shallow borrow. Landside shallow borrow allows for draining the borrow area so that it can be forested. Borrow excavation is limited to 3 feet deep and shaped to drain and connect to local drainage, thereby providing habitat for tree growth. As in the previous landside borrow areas, the required location is in a band 2,000 to 3,000 feet from the landside toe of the levee. Plate 51 (Appendix 4) shows a typical layout of borrow area location, excavation and levee enlargement, and forested borrow. This shallow borrow greatly expands the required borrow area acreage, increasing lands and damages costs commensurately.

Plan 3 - Traditional Method

18. Plan 3 is the traditional historical method to construct levee enlargements and berms. New and innovative designs to reduce the cross-sectional area of the levees have been incorporated and, where possible, the levee enlargement is located to the side requiring the least amount of material.

19. The borrow areas are normally located riverside as close to the construction site as engineeringly feasible (proper soil for levee embankment) and excavated as deep as soil layers will allow (see Plate 52, Appendix 4). This plan requires no special configuration or location of the borrow areas other than for engineering purposes. No provisions are made for drainage or environmental enhancement of the borrow areas. However, past experience has shown that a majority of the resulting borrow areas permanently hold water which is replenished or "flushed" periodically by normal river fluctuations.

20. The traditional method analysis consisted first of printing GIS maps that contain the following data layers: base topographic features, land cover mapping, jurisdictional wetland mapping, and items of work. The items of work layer included enlargement footprints, berm footprints, and original borrow areas. To develop the layout of the plan described as Plan 3, the engineering design team located the borrow areas for the traditional method on the items of work mapping layer.

Plan 4 - Environmental Design (Avoid-and-Minimize)

21. Plan 4 is an environmental design which incorporates measures to avoid and minimize environmental damages to bottom-land hardwoods and wetlands. To develop the layout of the plan, interdisciplinary teams of state and Federal agencies representatives, local sponsors, and Corps staff were formed. They initially focused on relocating the construction borrow areas using the following placement prioritization criteria as a guide.

a. Landside cropland from willing sellers.

b. Landside cropland when riverside locations were unavailable.

c. Riverside prior-converted cropland.

d. Riverside tree plantations.

e. Riverside farmed wetlands (cropland).

f. Riverside farmed wetlands (pasture).

g. Riverside herbaceous wetlands.

h. Riverside forested nonwetland.

i. Riverside forested wetland.

j. Landside and riverside bottom-land hardwoods with black bear presence.

k. Landside cropland condemnation.

22. However, as various methods of construction were evaluated for each work item, it became apparent that the prioritization criteria could not be strictly and consistently applied to the entire MRL study area. For example, in the New Orleans District, the area between the top bank of the river and the levee is relatively narrow and often developed, whereas in the Vicksburg District, these areas are relatively wide and undeveloped. Riverside land use in the Vicksburg District is split between cropland and forested, but in the Memphis District, the riverside land use becomes predominantly cropland. Rather than apply the prioritization scheme mechanically, the study team evaluated each individual item and applied the avoid-and-minimize techniques as was most reasonable, considering the environmental, economic, and engineering solutions available for that item.

23. The teams also considered other innovative design approaches for reducing bottom-land hardwoods and wetlands effects. When environmentally, economically, and engineeringly feasible, existing berm material may be used to enlarge the levee (see Plate 53, Appendix 4) and replace the excavated berm with material dredged from the river (see Plates 54 and 55, Appendix 4). As shown on Plate 54, the only environmental loss would be temporary and comprised of a narrow path in which to lay the dredge pipe from the river to the berm site while pumping dredged material. Plate 29, Appendix 4, shows the locations of work items 498.0-L, 497.0-L, 495.0-L, and 493.0-L (these four items have been combined and renamed work

item 496.0-L) and the dredge site locations in the Mississippi River to be used for borrow to construct these work items. The use of relief wells or cutoff trenches to control seepage instead of berms could be used if engineeringly and environmentally feasible. The relief wells or cutoff trenches would only temporarily affect the environment during construction.

Structural Alternatives Screening

24. The structural alternatives were screened to determine the most viable and implementable plans (see Project Report). Plans 3 and 4 were selected, carried forward into design, and evaluated in detail.

BASELINE CONDITIONS

25. The baseline, or existing, conditions used for the purposes of this report will be the conditions prior to any construction started in 1997. The future without-project conditions have been determined to be the existing conditions. This was decided because there are no significant changes in land use practices expected to occur within or adjacent to the levee system. Table 12-2 summarizes the existing conditions within the project area. Land use within the project area is primarily bottom-land hardwood forest followed by agriculture, with soybeans the major crop. Bottom-land hardwood forest comprises about 39 percent of the project area and agriculture accounts for approximately 29 percent.

TABLE 12-2
PROJECT AREA LAND USE
(Acres)

Land Use	Nonwetland	Wetland	Total
Forested	385,456	636,254	1,021,710
Cropland	537,704	231,556	769,260
Urban/Industrial	71,570	4,594	76,164
Scrub/Shrub	23,939	43,440	67,379
Tree Plantations	27,887	22,584	50,471
Sandbar	3,790	45,600 a/	49,390
Pasture	22,854	19,536	42,390
Levee	26,990		26,990

TABLE 12-2 (Cont)

Herbaceous	3,469	11,043	14,512
Marsh		5,925	5,925
Bare Soil	1,742	1,825	3,567
Subtotal	1,105,401	1,022,357	2,127,758
Open Water			518,086
Total			2,645,844

a/ Jurisdictional (regulated) water of the United States, but may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

26. Neotropical migratory birds known to regularly use or occupy the project area include 184 species representing 33 families (Table 12-3). This list contains 14 species considered to be of management concern based on classifications made by the U.S. Fish and Wildlife Service (1987 and 1991) and Mueller, et al. (in press). Species of management concern include the least bittern, American bittern, white-faced ibis, northern harrier, peregrine falcon, gull-billed tern, black tern, yellow-billed cuckoo, olive-sided flycatcher, loggerhead shrike, golden-winged warbler, cerulean warbler, prothonotary warbler, and Swainson's warbler.

TABLE 12-3
MISSISSIPPI RIVER NEOTROPICAL MIGRANTS

Podicipedidae	
Pied-billed Grebe	*Podilymbus podiceps*
Pelecanidae	
American White Pelican	*Pelecanus erythrorhynchos*
Brown Pelican	*Pelecanus occidentalis*
Phalacrocoracidae	
Double-crested Cormorant	*Phalacrocorax auritus*
Anhingidae	
Anhinga	*Anhinga anhinga*
Ardeidae	
American Bittern	*Botaurus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Tricolored Heron	*Egretta tricolor*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night-Heron	*Nycricorax nycticorax*
Yellow-crowned Night-Heron	*Nyctanassa violacea*
Threskiornithidae	
Glossy Ibis	*Plegadis falcinellus*
White-faced Ibis	*Plegadis chihi*
Ciconiidae	
Wood Stork	*Mycteria americana*
Cathartidae	
Black Vulture	*Coragyps atratus*
Turkey Vulture	*Cathartse aura*
Pandionidae	
Osprey	*Pandion haliaetus*

TABLE 12-3 (Cont)

Accipitridae	
Swallow-tailed Kite	*Elanoides forficatus*
Mississippi Kite	*Ictinia mississippiensis*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipter cooperii*
Broad-winged Hawk	*Buteo platypterus*
Falconidae	
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Rallidae	
King Rail	*Rallus elegans*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Purple Gallinule	*Porphyrio martinicus*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Charadriidae	
Black-bellied Plover	*Pluvialis squatarola*
American Golden-Plover	*Pluvialis dominicus*
Semipalmated Plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
Recurcirostridae	
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Scolopacidae	
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Willet	*Catoptrophorus semipalmatus*
Spotted Sandpiper	*Tringa macularia*
Upland Sandpiper	*Bartramia longicauda*
Ruddy Turnstone	*Arenaria interpres*
Red Knot	*Calidris canutus*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*

TABLE 12-3 (Cont)

Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Baird's Sandpiper	*Calidris bairdii*
Pectoral Sandpiper	*Calidris melanotos*
Dunlin	*Calidris alpina*
Stilt Sandpiper	*Micropalama himantopus*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopanceus*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor*
Wilson's Phalarope	*Steganopus tricolor*
Laridae	
Laughing Gull	*Larus atricilla*
Bonaparte's Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
Herring Gull	*Larus argentatus*
Gull-billed Tern	*Sterna nilotica*
Caspian Tern	*Sterna caspia*
Royal Tern	*Sterna maxima*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Least Tern	*Sterna antillarum*
Black Tern	*Chlidonias niger*
Columbidae	
White-winged Dove	*Zenaida asiatica*
Cuculidae	
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Yellow-billed Cuckoo	*Coccyzus americanus*
Caprimulgidae	
Common Nighthawk	*Chordeiles minor*
Chuck-will's widow	*Caprimulgus carolinensis*
Whip-poor-will	*Caprimulgus vociferus*
Apodidae	
Chimney Swift	*Chaetura pelagica*
Trochilidae	
Ruby-throated Hummingbird	*Archilochus colubris*

TABLE 12-3 (Cont)

Alcedinidae	
Belted Kingfisher	*Ceryle alcyon*
Picidae	
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Tyrannidae	
Olive-sided Flycatcher	*Contopus borealis*
Eastern Wood-Pewee	*Contopus virens*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Acadian Flycatcher	*Empidonax virescens*
Alder Flycatcher	*Empidonax alnorum*
Willow Flycatcher	*Empidonax traillii*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Western Kingbird	*Tyrannus verticalis*
Eastern Kingbird	*Tyrannus tyrannus*
Scissor-tailed Flycatcher	*Tyrannus forficatus*
Hirundinidae	
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Hirundo pyrrhonota*
Barn Swallow	*Hirundo rustica*
Troglodytidae	
Bewick's Wren	*Thryomanes bewickii*
House Wren	*Troglodytes aedon*
Sedge Wren	*Cistothrous platensis*
Marsh Wren	*Cistothorus palustris*
Muscicapidae	
Ruby-crowned Kinglet	*Regulus calendula*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Veery	*Catharus fuscescens*
Gray-cheeked Thrush	*Catharus minimus*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttalus*
Wood Thrush	*Catharus mustelinus*
American Robin	*Turdus migratorius*

TABLE 12-3 (Cont)

Mimidae	
Gray Catbird	*Dumetella carolinensis*
Bombycillidae	
Cedar Waxwing	*Bombycilla cedrorum*
Laniidae	
Loggerhead Shrike	*Lanius ludovicianus*
Vireonidae	
White-eyed Vireo	*Vireo griseus*
Bell's Vireo	*Vireo belii*
Solitary Vireo	*Vireo solitarius*
Yellow-Throated Vireo	*Vireo flavifrons*
Warbling Vireo	*Vireo gilvus*
Philadelphia Vireo	*Vireo philadelphicus*
Red-eyed Vireo	*Vireo olivaceus*
Emberizidae	
Blue-winged Warbler	*Vermivora pinus*
Golden-winged Warbler	*Vermivora chrysoptera*
Tennessee Warbler	*Vermivora peregrina*
Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
Northern Parula Warbler	*Parula americana*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Magnolia Warbler	*Dendroica magnolia*
Cape May Warbler	*Dendroica tigrina*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronata*
Black-throated Green Warbler	*Dendroica virens*
Blackburnian Warbler	*Dendroica fusca*
Yellow-throated Warbler	*Dendroica dominica*
Pine Warbler	*Dendroica pinus*
Prairie Warbler	*Dendroica discolor*
Palm Warbler	*Dendroica palmarum*
Bay-breasted Warbler	*Dendroica castanea*
Blackpoll Warbler	*Dendroica striata*
Cerulean Warbler	*Dendroica cerulea*
Black-and-White Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Prothonotary Warbler	*Protonotaria citrea*
Worm-eating Warbler	*Helmitheros vermivorus*

TABLE 12-3 (Cont)

Swainson's Warbler	*Limnothlypis swainsonii*
Ovenbird	*Seiurus aurocapillus*
Northern Waterthrush	*Seiurus noveboracensis*
Louisiana Waterthrush	*Seiurus motacilla*
Kentucky Warbler	*Oporornis formosus*
Mourning Warbler	*Oporornis philadelphia*
Common Yellowthroat	*Geothlypis trichas*
Hooded Warbler	*Wilsonia citrina*
Wilson's Warbler	*Wilsonia pusilla*
Canada Warbler	*Wilsonia canadensis*
Yellow-breasted Chat	*Icteria virens*
Summer Tanager	*Piranga rubra*
Scarlet Tanager	*Piranga olivacea*
Rose-breasted Grosbeak	*Pheucticus hudovicianus*
Blue Grosbeak	*Guiraca caerulea*
Indigo Bunting	*Passerina cyanea*
Painted Bunting	*Passerina ciris*
Dickcissel	*Spiza americana*
Chipping Sparrow	*Spizella passerina*
Clay-colored Sparrow	*Spizella pallida*
Vesper Sparrow	*Pooecetes gramineus*
Savannah Sparrow	*Passerculus sandwichensis*
Grasshopper Sparrow	*Ammodramus savannarum*
Lincoln's Sparrow	*Melospiza lincolnii*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Bronzed Cowbird	*Molothrus aeneus*
Brown-headed Cowbird	*Molothrus ater*
Orchard Oriole	*Icterus spurius*
Baltimore Oriole	*Icterus galbula*
Fringillidae	
American Goldfinch	*Carduelis tristis*

IMPACT ANALYSIS

27. This section defines the impacts of Mississippi River Mainline levee enlargement and seepage control through a comparison of baseline conditions with those that would exist upon project completion. For purposes of this report, only Plans 3 and 4 of the structural alternatives were considered in detail. Table 12-4 indicates the land use changes that would occur following construction for each plan, not including reforestation efforts. The land use changes would primarily result from borrow area construction followed by seepage control measures and levee enlargement. In general, borrow areas would be located along the edge of forested areas and/or cropland. Levee enlargement would require widening the levee footprint and therefore, would alter both forested areas and cropland (see the Project Report for more detailed information).

TABLE 12-4
ESTIMATED LAND USE CHANGES RESULTING FROM CONSTRUCTION
(Acres)

Land Use Classification	Nonwetland		Wetland		Total	
	Plan 3 Traditional	Plan 4 Avoid-and-Minimize	Plan 3 Traditional	Plan 4 Avoid-and-Minimize	Plan 3	Plan 4
Forest	3,646	2,073	7,929	2,760	11,575	4,833
Cropland	6,530	6,532	2,094	3,220	8,624	9,752
Urban/Industrial	162	165	87	65	249	230
Scrub Shrub	175	164	405	245	580	409
Tree Plantation	248	585	331	498	579	1,083
Pasture	300	376	478	351	778	727
Levee	652	611	58	45	652	656
Herbaceous	117	99	289	167	406	266
Marsh			40	21	40	21
Open Water					586	1,019

28. The effects of the proposed changes in land use on the Neotropical migrant birds have been estimated in Table 12-5. Species have been grouped by families, and habitat types have been grouped into the following categories: CL = cropland, levees; FF = forest; Hb = herbaceous, pasture, old field, and scrub shrub; Tp = tree plantation; Msh = marsh; ↑ = increase in habitat; and ↓ = decrease in habitat.

TABLE 12-5
ESTIMATED POPULATION RESPONSE TO PROPOSED LAND USE CHANGES a/

Family (# of species)	CL ↑	CL ↓	FF ↑	FF ↓	Hb ↑	Hb ↓	TP ↑	TP ↓	Msh ↑	Msh ↓
Grebes (1)	nc	nc	nc	nc	nc	nc	nc	nc	++	--
Pelicans (2)	nc	nc	nc	nc	nc	nc	nc	nc	+	-
Cormorants (1)	nc	nc	nc	nc	nc	nc	nc	nc	+	-
Anhinga (1)	nc	nc	+	-	nc	nc	nc	nc	+	-
Bitterns, Green Heron (3)	nc	nc	nc	nc	+	-	nc	nc	++	--
Other herons, ibis (9)	nc	nc	+	-	+	-	+	-	++	--
Wood stork (1)	nc	nc	+	-	nc	nc	+	-	++	--
Vultures (2)	+	-	+	-	-	+	+	-	nc	nc
Accipiters (2)	nc	nc	++	--	+	-	+	-	+	-
Buteos (1)	nc	nc	++	--	+	-	+	-	+	-
Osprey (1)	nc	nc	++	++	+	-	+	-	++	--
Harriers (1)	+	-	-	+	+	-	-	+	++	--
Kites (2)	nc	nc	++	--	+	-	+	-	+	-
Falcons b/ (3)	+	-	+	-	nc	nc	nc	nc	+	-
Rails, Gallinules, Coots	nc	nc	nc	nc	+	-	nc	nc	++	--
Large plovers inc. Upland Sandpiper & Buff-breasted Sandpiper (5)	+	-	nc	nc	nc	nc	nc	nc	nc	nc
Small plovers and sandpipers (22)	nc	nc	nc	nc	nc	nc	nc	nc	+	-
Common Snipe (1)	nc	nc	nc	nc	nc	nc	nc	nc	++	--
American Woodcock (1)	nc	nc	++	--	+	-	+	-	nc	nc
Doves (1)	+	-	nc	nc	++	--	nc	nc	nc	nc
Cuckoos (2)	nc	nc	++	--	+	-	+	-	+	-
Nightjars c/ (3)	+	-	+/-	+/-	nc	nc	+	-	+	-
Swifts (1)	nc	nc	+	-	nc	nc	nc	nc	+	-

TABLE 12-5 (Cont)

Family (# of species)	CL ↑	CL ↓	FF ↑	FF ↓	Hb ↑	Hb ↓	TP ↑	TP ↓	Msh ↑	Msh ↓
Hummingbirds (1)	nc	nc	+	-	++	--	+	-	+	-
Kingfishers (1)	nc	nc	+	-	nc	nc	nc	nc	+	-
Woodpeckers (1)	nc	nc	++	--	+	-	+	-	nc	nc
Tyrant Flycatchers (9)	-	+	++	--	+	-	+	-	+	-
Kingbirds, Scissor-tailed Flycatcher (3)	+	-	-	+	++	--	-	+	++	--
Swallows (6)	nc	nc	nc	nc	+	-	+	-	++	--
Wrens (4)	nc	nc	+	-	+	-	+	-	+	-
Old world flycatchers & thrushes (8)	+/-	+/-	++	--	+	-	+	-	nc	nc
Mockingbirds & Thrashers (1)	nc	nc	+	-	++	--	+	-	+	-
Waxwings (1)	nc	nc	++	--	++	--	+	-	+	-
Vireos (7)	nc	nc	++	--	+/-	-/+	+	-	nc	nc
Warblers (36)	nc	nc	++	--	+/-	-/+	+	-	+	-
Tanagers & Grosbeaks (5)	nc	nc	++	--	+	-	+	-	nc	nc
Buntings and Sparrows (10)	-	+	+	-	++	--	+	-	+	-
Blackbirds (4)	++	--	-	+	+	-	-	+	+	-
Rusty Blackbird & Orioles (3)	-	+	++	--	++	--	+	-	++	--
Finches (1)	-	+	+	-	++	--	+	-	+	-

a/ Population responses to land use changes are indicated by: nc = no change; + = slightly positive; ++ = very positive; - = slightly negative; - - = very negative; and ± = species within the group respond positively and negatively.

b/ Falcons--American kestrel would show a slight positive response to increases in cleared land and levees due to increases in prey while Merlin and Peregrine would show slight negative response due to decreases in prey.

c/ Nightjars--Common Nighthawk would respond positively to increases in cropland, cleared land, and levees, but Whip-poor--will and Chuck-will's Widow would respond negatively. The latter two species would respond positively to decreases in cropland and levee, but Common Nighthawk would respond negatively to increases in forest cover.

Rusty Blackbird is categorized with the orioles due to habitat preferences.

29. The primary impact to Neotropical migratory birds would be the conversion of breeding, resting, and foraging habitat to project features. Based on the estimated responses, a decrease in forested habitat would be the greatest negative impact to Neotropical migrants. The combination of herbaceous, pasture, old field, and scrub/shrub habitat is also important habitat. The breeding season for many Neotropical migrants typically occurs during mid-April through June. Also, the impacts to foraging and stopover habitats would be offset by the mitigation measures for terrestrial wildlife habitat and wetlands. Habitat fragmentation has been reduced with Plan 4, and significant benefits would be derived from the reforestation efforts.

30. The U.S. Fish and Wildlife Service, Vicksburg Field Office, has recorded the breeding activity of known colonial waterbirds within the Vicksburg and Memphis District study boundaries. These colonies often return to nest in the same general location from year to year. No known colonies are located within alternative Plan 4 proposed work areas and only one colony is located as close as 0.5 mile from proposed work. Also, no known colonies are located within or adjacent to the proposed work items within the New Orleans District. Therefore, no significant adverse impact to colonial waterbirds would be expected to result from the proposed work, although positive benefits would accrue following borrow area construction.

SPECIES OF MANAGEMENT CONCERN

31. Least bittern are local breeders in the lower Mississippi River valley, breeding in emergent marshes and along the edges of oxbows and backwater ponds and occasionally at some well-vegetated borrow areas. The bird is more frequently encountered as a migrant, but occurs commonly only below New Orleans, Louisiana, where it is found year-round. Favored habitats for breeding include large expanses of both cattail and bulrush marshes. The species is a non-colonial breeder. Any decrease in marsh acreage would have an adverse impact upon this species as least bitterns can successfully breed in very small acreages of marsh.

32. American bittern are local, uncommon to usually rare, breeding birds in the lower Mississippi River valley from western Tennessee northwards. During migration, the species occurs throughout the lower Mississippi River valley with wintering birds possible from Cairo south to the Gulf. The main wintering grounds are the extensive fresh and intermediate marshes in coastal Texas and southern Louisiana. Occasionally, the species occurs in human-created habitats such as ricefields and borrow areas. American bitterns do not breed in colonies. This species requires extensive marshlands both for breeding and wintering. Slight decreases or increases in available marshland would have no impact on this species.

33. White-faced ibis are fairly common residents from New Orleans south where they are outnumbered by the similar Glossy ibis. This species favors fresh-water marshes where it feeds for snails and other invertebrates in shallow water. It breeds in single-species and mixed heron-ibis colonies. Colonies are usually situated in low willows or other trees in the middle of a large marsh. Existing colonies south of New Orleans are not in the vicinity of worksites. Protection of its breeding colonies from disturbances and preservation of the wetlands where it forages are the major management steps required to preserve this locally occurring bird.

34. The northern harrier or marsh hawk is an uncommon to fairly common migrant and winter resident in the lower Mississippi River valley. It favors agricultural landscapes or large marshes with some existing cover for foraging and roosting. During migration, the species is found over a variety of open habitats, but seldom remains long in the vicinity of the river unless marshes or old

fields are present. Any increase in marshes would have a positive effect on this species. Increases in pasture/old field and herbaceous growth would also favor this species, but increase in cropland would have either no effect or a slightly negative effect unless suitable nearby cover was also available.

35. The peregrine falcon was formerly a tree-breeding resident of the lower Mississippi River valley, breeding in bottom-land forests in northeastern Louisiana and in the Reelfoot Lake area of western Tennessee. This unique population was extirpated by the early 1950's. Currently, the peregrine falcon is a rare spring migrant and uncommon to fairly common fall migrant in the Mississippi River valley, most often recorded from early March through April and from mid-September to mid-November. The peregrine is not limited to the river itself and may be seen in migration anywhere in the valley. Favored foraging locations include waterfowl refuges with concentrations of ducks, geese, and shorebirds and marshes and fields with dead trees utilized for hunting perches. Neither Plan 3 nor Plan 4 will have a major impact on this species. Plan 3 would result in only a slightly decreased prey base that might result in peregrines tending to move more quickly through the area rather than remaining to forage.

36. The gull-billed tern is found breeding only in southern Louisiana from New Orleans southward to the Gulf of Mexico. In the New Orleans area, gull-billed terns breed on rooftops of large buildings due apparently to the lack of natural nest sites, while in the lower Delta region, the species breeds on sandbars and dredged material disposal islands. It frequents quiet backwaters, marshes, and borrow areas for foraging during the breeding season. Any increase in borrow areas would favor this bird, although the species would respond negatively to any decrease in marshes.

37. The black tern is known only as a regular, fairly common migrant in the lower Mississippi River valley, more prevalent in fall (July-September) than in spring. It seems to prefer foraging in quiet backwaters and oxbows, but also forages in the open river. Occasionally, small numbers will forage in borrow areas. It roosts on sandbars, sometimes in close proximity to the breeding least terns which breed on these bars. A decrease in sandbars would have a slight negative effect on migrant black terns. An increase in borrow areas would likely have no effect on black terns.

38. The yellow-billed cuckoo has exhibited both long-term and recent declines in the eastern and central United States. It prefers moderately dense thickets near water courses, second growth woodlands, deserted farmlands overgrown in shrubs, and brush and brushy orchards. It tends to nest in dense shrubby vegetation overgrown with vines or in deciduous trees on horizontal limbs less than 20 feet above the ground. A decrease in forest habitat or forest fragmentation would have negative impacts on this species. Reforestation, primarily in large tracts, would benefit the yellow-billed cuckoo.

39. Olive-sided flycatchers are usually rare spring migrants in the lower Mississippi River valley and rare to uncommon fall migrants, in passage from mid- to late April to late May and in August and September. They are low-density migrants, and it is seldom when more than one or two birds occur in an area at a time. They prefer to forage from large canopy emergent trees in forested areas, from the tops of dead trees in marshes, or on the edges of weedy fields. Wet habitats seem to be a frequent component in their habitat preferences. Any decrease in mature forest or in marshes with forested edges or isolated trees would impact this species negatively. As mature forest is the preferred habitat, any mitigation required to compensate for loss of this habitat would not result in habitat replacement for several decades.

40. Loggerhead shrikes inhabit pastures, old fields, open forest edges, scrubland, and parkland in the lower Mississippi River valley. The species is resident from Cairo to the lower Delta. Breeding populations are augmented fall through spring with wintering birds moving south from the midwest. Although most birds from Natchez north favor upland field habitats and open oak forests, lower numbers inhabit riverine ash-elm-cottonwood associations adjacent to the river from Old River and Natchez south. Some studies have found that at least one limiting factor for this species is the lack of foraging perches. Shrikes appear to be absent from many open country and agricultural landscapes where there are few suitable foraging perches and low trees or hedgerows in which to breed. Any increase in scrub/shrub and old field habitat would have a positive impact on this species. Clearing of closed canopy forest may have a positive impact if sufficient old field/scrub habitat with foraging perches is created by the tree removal.

41. Golden-winged warblers are uncommon to occasionally fairly common migrants locally in the lower Mississippi River valley. They migrate from mid-April through late May and from early September to late October, occurring singly or in small groups or families. During spring migration, the species prefers low to mid-story forest vegetation but seems to frequent low-level vegetation more frequently in the fall, occurring in forests, scrub-shrub, and sometimes in herbaceous patches such as ragweed stands (*Ambrosia* spp.). A decrease in forested habitat would have a slight negative effect on this species, particularly during spring migration. Any increase in herbaceous growth or forest would have a positive effect on this species.

42. The cerulean warbler is a local, usually uncommon, breeding bird from northeastern Louisiana where rare and local north to the north end of the project area. The species arrives in April from South American wintering grounds and departs in August or September. It is rarely seen during fall migration with most resident birds departing unnoticed. This warbler prefers the upper levels of mature forests for breeding and is most frequent in large blocks of unbroken forest. Its susceptibility to brown-headed cowbird parasitism is lower than most other Neotropical breeding species, perhaps due to the placement of the nest in the upper canopy. During spring migration the cerulean warbler forages in mid-story bottom-land hardwood forest, and in the fall, it frequents both mid-story and understory vegetation. Any decrease in mature forest habitat would have a negative impact on this species during the breeding season. Any increase in forest habitat would positively benefit this species during fall migration, but only an increase in mature forest habitat would benefit this species during the breeding season and spring migration.

43. Prothonotary warblers are primarily associated with moist bottom-land or swampy deciduous forests, including frequently flooded areas and willow-lined streambanks. The prothonotary is the only eastern cavity nesting warbler, generally nesting in old woodpecker or chickadee holes 5 to 10 feet high in stumps or snags in or near water. A reduction of forested habitat would have a negative impact, although the construction of borrow areas would increase its preferred habitat by adding edge habitat. Any increase in forested habitat, primarily in wet/moist areas, would benefit the protonotary warbler.

44. Swainson's warbler is a generally uncommon warbler which, within the project area, inhabits rich, damp woodlands with deep shade and dense undergrowth including wooded swamps and canebrakes of lowlands in large unbroken tracts. In lowlands, nests are commonly large and bulky in cane or palmetto from 3 to 5 feet above the ground. This warbler is susceptible to cowbird parasitism which is increased during forest fragmentation. Therefore, like the other warblers, a reduction of forest habitat or forest fragmentation would have a negative impact and any increase in forest habitat would be beneficial.

CONCLUSIONS

45. The lower Mississippi River Mainline levees enlargement and seepage control would adversely impact Neotropical migratory birds by altering breeding, feeding, and resting/stopover habitat. Implementation of Plan 4 would result in no significant impact to Neotropical migratory birds due to the avoidance of 6,742 acres of forested habitat, reforestation of 3,041 acres of borrow areas, and 5,863 acres of frequently flooded agricultural lands within the project area. This conclusion was reached after a review of appropriate literature for each species in question and the inclusion, as appropriate, of environmental design measures to ensure that the proposed construction would minimize adverse impacts.

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APPENDIX 13
WETLANDS FUNCTIONAL ANALYSIS

ABSTRACT

A semiquantitative method developed by the Wetland Evaluation Work Unit of the Wetland Research Program at the U.S. Army Engineer Waterways Experiment Station was used to evaluate functional impacts to forested and farmed wetlands. Wetland functions evaluated were short-term water storage, long-term water storage, water velocity reduction, sediment detention, onsite erosion control, nutrient and dissolved substance removal, and organic carbon export. Wetland functional impacts were expressed as functional capacity units, which reflect both the quantity and quality of wetland functional values. Functional capacity units were determined by multiplying the functional capacity index value of each function by the acreage affected. Functional index values ranged from 0 to 1, with 1 representing optimal wetland value.

No-action, nonstructural, and structural alternatives were considered. The wetland functional analysis was performed on only structural Plans 3 and 4. Wetland functional capacity would likely remain unchanged with implementation of the no-action and Plan 1 (nonstructural) alternatives. Plan 2 (landside borrow alternative) would significantly reduce wetland impacts riverside of the levees. Wetland impacts would still occur from borrow area construction landside of the levee, but to a lesser degree. In addition, wetland functional value would be provided by the forested buffer strips around the landside borrow areas. Impacted wetland acreage for Plan 3 represents 1.1 percent (11,654) of project area wetlands, and Plan 4 impacts represent 0.7 percent (7,340) of project area wetlands. Plan 3 would result in the loss of 54,075 average annual functional capacity units (AAFCU) and Plan 4 would cause the loss of 25,035 AAFCU's. Forested wetlands account for 94 percent of the AAFCU loss under Plan 3 and 83 percent under Plan 4. Approximately 3,000 acres of borrow area with Plan 4 would be reforested.

The use of avoid-and-minimize techniques in Plan 4 would result in a 44 percent reduction in the AAFCU loss in the Vicksburg District, an 81 percent reduction in the Memphis District, and a total project reduction of 54 percent. Plan 3 does not include compensation for unavoidable wetland functional value. Reforestation of 5,863 acres of frequently flooded agricultural lands would be necessary to achieve a no-net-loss of wetland functional value with implementation of Plan 4. This compensatory mitigation combined with reforestation of borrow areas produces a net gain in wetland functional value.

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 13
WETLAND FUNCTIONAL ANALYSIS

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MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
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APPENDIX 13
WETLAND FUNCTIONAL ANALYSIS

INTRODUCTION

1. The Mississippi River and Tributaries Project has four major components: levees to contain floodflows; floodways to pass excess flows past critical Mississippi River reaches; channel improvement and stabilization to provide efficient navigation alignment, increased flood-carrying capacity, and protection of the levee system; and tributary basin improvements. Project authority is the Flood Control Act of 1928.

2. Stage-discharge information developed from a major 1973 flood indicated channel capacity of the lower Mississippi River and the lower portion of the Atchafalaya Basin Floodway had deteriorated (based on the 1956 flow line). A new design flow line demonstrated the need to raise portions of the levee system to protect against the project flood. Changes were made in the design levee grade to contain flows under 1973 river conditions. The authorized flood protection did not change. Levee enlargement and seepage control measures are necessary to maintain the integrity of the Mississippi River levee system. Proposed construction activities would occur in the U.S. Army Corps of Engineers, Vicksburg, Memphis, and New Orleans Districts, affecting the states of Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. Complete project and construction item descriptions are in the Project Report and Engineering Appendix.

ALTERNATIVES

3. Refer to the Project Report for detailed alternative descriptions. The array of alternatives was:

a. No action. No new construction and continue normal maintenance. No forested or farmed wetland impacts.

b. Plan 1. Nonstructural flood damage reduction. Normal project maintenance would continue. Easements would be acquired on acres potentially inundated by levee failures.

c. Plan 2. Continue construction to include seepage control, frontal protection and levee enlargement. All borrow would be obtained from the landside of the levee.

d. Plan 3. Continue construction to include seepage control, frontal protection and levee enlargement. Borrow material would be taken from the nearest, engineeringly feasible area (traditional method). No compensation would be provided.

e. Plan 4. Continue construction to include seepage control, frontal protection and levee enlargement. Environmental impacts would be avoided and minimized to the maximum extent practicable by relocating borrow areas, using relief wells and slurry trench cutoffs in lieu of berms, and using existing berm material for levee enlargement and replacing it with material dredged from the river. Compensation for unavoidable impacts would be included.

OBJECTIVES

4. The evaluation objectives were to (a) identify wetland functions, (b) evaluate wetland functions, (c) assess the effects of Plans 3 and 4 on wetland functions, (d) determine environmental design (reforestation) benefits, and (e) determine appropriate compensation measures to offset unavoidable impacts.

LIMITS OF ANALYSIS

5. This analysis considered only Plans 3 and 4. Wetland functional capacity would likely remain unchanged with implementation of the no-action and Plan 1 alternatives. Plan 2 would significantly reduce wetland impacts riverside of the levees. Wetland impacts would likely still occur from borrow area construction landside of the levee, but to a lesser degree. In addition, wetland functional value would be provided by the forested buffer strips around the landside borrow areas (see Engineering Appendix for descriptions).

PROJECT AREA AND METHODS

PROJECT AREA

6. The New Orleans District portion extends from the Head of Passes, Louisiana, to approximately the Louisiana-Mississippi border. All proposed construction would occur in Louisiana. The Vicksburg District portion extends north to Rosedale, Mississippi. Proposed construction would occur in Mississippi, Louisiana, and Arkansas. The Memphis District portion extends upstream to Cape Girardeau, Missouri. Proposed construction would occur in Arkansas, Illinois, Kentucky, Mississippi, Missouri and Tennessee.

7. Forested and cropland cover types account for 68 percent of the project area (Table 13-1). Sixty-two percent of the forested and 30 percent of the cropland areas are wetlands. Forty-eight of the land in the project area is wetlands.

TABLE 13-1
PROJECT AREA LAND USE ACREAGE

Land Use	Nonwetland	Wetland	Total
Forested	385,456	636,254	1,021,710
Cropland	537,704	231,556	769,260
Urban/Industrial	71,570	4,594	76,164
Scrub/Shrub	23,939	43,440	67,379
Tree Plantations	27,887	22,584	50,471
Sandbar	3,790	45,600 a/	49,390
Pasture	22,854	19,536	42,390
Levee	26,990		26,990
Herbaceous	3,469	11,043	14,512
Marsh		5,925	5,925
Bare Soil	1,742	1,825	3,567
Subtotal	1,105,401	1,022,357	2,127,758
Open Water			518,086
Total			2,645,844

a/ Jurisdictional (regulated) water of the United States but may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

DELINEATION

8. The jurisdictional wetland determination includes all lands riverside of the landside toe of the mainline Mississippi River levee (on both sides) from near Cape Girardeau, Missouri, to Head of Passes, Louisiana, and an area 3,000 feet landside of the levee toe (on both sides). The 1987 Corps of Engineers Wetland Delineation Manual with supplemental guidance was the basis for determining the extent of jurisdictional wetlands for vegetated areas. Wetlands on agricultural lands were identified using procedures in the National Food Security Act Manual (3rd Edition). Because of the project's regional scale, offsite procedures were used to establish the approximate extent of jurisdiction. The Natural Resource Conservation Service was consulted for the offsite jurisdictional determination on agricultural lands. Offsite information was entered into a geographic information system and used to produce preliminary jurisdictional maps which were ground-truthed by an interagency team represented by U.S. Army Corps of Engineers; Natural Resources Conservation Service; Environmental Protection Agency; U.S. Fish and Wildlife Service; state Departments of Environmental Quality; Game and Fish; private landowners; levee boards; and the Sierra Club. Because of the extensive project area, assumptions were made about vegetation, soils, and hydrology based upon preliminary field

investigations and available statistical data. Detailed information on the assumptions and process used in the delineation is provided in Attachment 1. Project wetland maps are in Appendix 4.

FUNCTIONAL ANALYSIS

9. A semiquantitative method developed by the Wetland Evaluation Work Unit of the Wetland Research Program at the U.S. Army Engineer Waterways Experiment Station was used to evaluate impacts to forested and farmed wetlands (Smith et al., 1995). The method was modified for use in a series of major water resource projects in the Delta portion of the Yazoo Basin, Mississippi (CEMVK, 1996). Construction impacts of these major water resource projects are similar to those expected for this project. This methodology was considered appropriate for this project area because:

a. The method was developed for riverine assessment and is based on wetland principles applicable to all sites.

b. The wetland functions were evaluated in a broad context.

c. The index values are relative to a theoretical optimally functioning wetland based on field observation rather than index values derived from site-specific data.

d. Construction impacts are similar to impacts associated with construction in the Yazoo Basin.

e. The method is sufficient to estimate the direction, duration, and magnitude of impacts and allows computation of any compensation measures.

f. Five of the seven functions associated with existing bottom-land hardwoods were determined to have the highest possible value (1.0); therefore, bottom-land hardwoods in the entire project area were considered to have the highest possible functional capacity. This results in a generous estimate of wetland impacts.

g. Eighty-three percent of wetland acreage impacted by Plan 3 and 84 percent impacted by Plan 4 occur in Mississippi, Louisiana, and Arkansas, the three states that contain or are the closest to the Yazoo Basin.

The functional capacity units (FCU's) are units that reflect both the quality and quantity of a wetland function. For purposes of this analysis the forested, tree plantations, scrub/shrub, herbaceous and marsh cover types were included in forested wetlands. Cropland, pasture, and levee cover types were included in farmed wetlands. This was based on:

a. A small percentage of the impacts occur in the scrub/shrub (3 percent), herbaceous (2 percent), marsh (0.3 percent), and urban (1 percent) cover type.

b. These cover types will occur interspersed in areas reforested for environmental design or compensation.

c. The difficulty in recreating some cover types.

d. The goal is to evaluate and offset wetland functional capacity impacts.

e. Although the functional values considered in this analysis may vary somewhat with these cover types, they have been included in a category that provides the highest possible index value for most functions.

10. Because there would be no change in hydrology, only conversion impacts (change to another land use) were considered. This methodology evaluated hydrology, vegetation cover, roughness coefficients, and other factors to determine:

a. Differences in functional capacity among the affected wetland types.
b. Land use conversion impacts on wetland functions.
c. Changes in functional capacity units by wetland type.
d. Environmental design (reforestation) benefits.
e. Compensation for unavoidable impacts.

WETLAND FUNCTIONS

11. The forested and farmed wetland functions evaluated were:

a. Short-term water storage
b. Long-term water storage
c. Water velocity reduction
d. Sediment detention
e. Onsite erosion control
f. Nutrient and dissolved substance removal
g. Organic carbon export

WETLAND PROPERTIES

12. The discussion of wetland functional properties was derived from Appendix G, Project Report and Supplement No. 2 to the Final Environmental Impact Statement, Flood Control, Mississippi River and Tributaries, Yazoo Basin, Mississippi (CEMVK, 1996).

13. Short-term water storage (STWS) is the wetland ability to store water during flood events. Short-term storage protects downstream areas by attenuating and/or delaying flood peaks. The degree of protection is a function of the amount and duration of water stored in the wetland. Both forested and farmed wetlands provide surface roughness and space for water storage, both of which delay the downstream movement of floodwater.

14. Long-term water storage (LTWS) is the wetland ability to store water in depressions between flood events. Long-term storage is a function of the wetland's capacity to receive over bank/backwater flooding and flood plain topography. Forested wetlands provide long-term storage in oxbow lakes, sloughs, and swales that have surface hydrologic connection with the river. This function plays an important role in sediment detention and removal of dissolved substances from floodwaters.

15. Water velocity reduction (WVR) is the wetland ability to reduce floodwater velocity across the ground surface. Forested wetlands exhibit larger roughness coefficients than farmed wetlands, and therefore, impede water movement to a greater degree. Velocity reduction is important in sediment detention.

16. Sediment detention (SD) is the wetland capacity to remove suspended organic and inorganic material from floodwaters flowing over the wetland surface. This capacity is related to the ability to receive floodwaters (short-term water storage capacity) and the ability to slow surface water (water velocity reduction capacity). Forested wetlands have the capacity to detain floodwater sediment because wetland roughness reduces flow velocity, decreasing the energy required to maintain particles in suspension. Farmed wetlands have a lower capacity to store water and less ability to slow water velocity than forested wetlands.

17. Onsite erosion control (OSEC) is the wetland ability to reduce shoreline and bank material loss from the kinetic energy forces of moving water. The dense, shallow root systems and large volume of surface vegetation of forested wetlands reduce the water's kinetic energy and effectively minimize erosion of soil particles.

18. Nutrient and dissolved substance removal (NDSR) is the wetland ability to remove dissolved compounds by plant assimilation, sediment adsorption, or transformation of inorganic nitrogen into gaseous forms which escape into the atmosphere. Persistent, woody vegetation provides for long-term nutrient removal from the sediment and ultimately the water. Nutrients are adsorbed on clay micelles and released into solution depending on the nutrient concentration gradient between the sediment and water. Forested wetlands provide litter surface area for the biochemical conversions of inorganic nitrogen.

19. Organic carbon export (OCE) is the wetland ability to transfer the degradation products of primary productivity to downstream aquatic ecosystems by floodwater transport. Exported organic carbon is an important energy source for the aquatic food web. Forested wetlands are important sources of organic carbon because the fluctuating hydrologic regime permits export of organic carbon from decaying litter.

FUNCTIONAL CAPACITY INDICES

20. A functional capacity index (FCI) value between 0.0 and 1.0 was used to quantify each wetland type and function combination (e.g., short-term water storage on forested wetland). A FCI of 1.0 represents the highest functional capacity, and 0.0 represents an absence of functional capacity. Wetlands with a FCI of 1.0 exhibit conditions similar to wetlands which were considered to have the optimum functional capacity possible for wetlands in the project area. These FCI values were developed and refined over a series of major water resource projects in the Yazoo Basin, Mississippi. The FCI for each wetland type and function combination was determined by:

$$FCI = \frac{\text{Functional capacity under existing conditions}}{\text{Functional capacity under optimal conditions}}$$

21. FCI's for STWS (FCI_{STWS}) were equal to the storage index (SI) values. SI is the relative ability to store water from overbank flooding. Forested and farmed wetlands were assigned SI values according to their capacity to store water on a per-acre basis of wetland area. Forested areas were assigned an SI value of 1.0 because they are not filled and have a higher roughness coefficient than farmed wetlands. Farmed wetlands were assigned an SI value of 0.5 because they may contain fill, exhibit lower roughness coefficients, and often have drainage systems. (These factors reduce the capacity to store water).

22. FCI's for LTWS (FCI_{LTWS}) were the product of the FCI_{STWS} and a ponding index (PI). Forested wetlands were assigned a PI of 1.0 because they have a high capacity for floodwater storage. Forested wetlands generally contain fewer drainage ditches, levees, and less fill than farmed wetlands. Farmed wetlands were assigned a PI of 0.5 because of increased floodwater conveyance.

23. FCI's for WVR(FCI_{WVR}) were equal to the roughness index (RI). The RI was calculated using Mannings *n* roughness coefficient values (Chow, 1959). An 0.12 value was assigned to forested wetlands and was assumed to be the maximum (optimum) Mannings *n* value. RI values were 1.0 for forested wetlands and 0.29 for farmed wetlands. RI values were calculated using:

$$\text{Forested wetland RI} = \text{Mannings } n_{Forested} \,/\, \text{Mannings } n_{Optimum}$$
$$\text{Farmed wetland RI} = \text{Mannings } n_{Farmed} \,/\, \text{Mannings } n_{Optimum}$$

Where:

$$\text{Mannings } n_{Forested} = 0.12 \text{ (Forested)}$$
$$\text{Mannings } n_{Farmed} = 0.035 \text{ (Farmed)}$$

FCI's for SD (FCI_{SD}) were the product of the FCI_{STWS} and FCI_{WVR}.

24. FCI's for OSEC (FCI_{OSEC}) were the product of FCI_{LTWS}, FCI_{WVR}, and the disturbance index (DI). The DI is the relative deviation of the wetland from the original bottom-land hardwood forest and is most closely related to the level of human activity in the wetland. Increased disturbance causes reduced root biomass, removal of litter, and reduced surface roughness (Scott et al., 1990). Increased disturbance also reduces the wetland's ability to provide onsite erosion control. Forested wetlands were assigned a DI value of 0.67, and farmed wetlands were assigned a DI value of 0.33. The DI value is proportional to the level of disturbance, and because most forested wetlands have had some degree of impact, no 1.0 values were assigned.

25. FCI's of NDSR (FCI_{NDSR}) were the product of FCI_{LTWS}, primary productivity index (PPI), and surface area index (SAI). The PPI ranks the primary productivity of forested and farmed wetlands. The PPI values were 1.0 and 0.67 for forested and farmed wetlands, respectively. SAI is the relative litter surface area available for inorganic transformations to occur. SAI values for forested farmed wetlands were 0.67 and 0.33, respectively.

26. FCI's for OCE (FCI_{OCE}) were the product of FCI_{STWS} and the PPI. The PPI reflects the amount of carbon produced by the vegetation, and the FCI_{STWS} reflects the floodwater's capacity to enter the system and flush organic carbon to downstream aquatic ecosystems.

27. FCI equations are summarized in Table 13-2. Five forested wetland functions had FCI values of 1.0 and two had values of 0.67 (Table 13-3). Farmed wetland FCI's ranged from 0.02 to 0.50. To determine compensation for unavoidable impacts and environmental design benefits, an annualized FCI for reforestation of frequently flooded agricultural lands was calculated for each function (Table 13-3). These FCI's assume a linear recovery of full functional capacity over 20 years, and were annualized over the project life (100 years). The FCI's represent the net gain in functional value of reforesting farmed wetlands (i.e., the functional value of the reforested wetland minus the functional value of the frequently flooded agricultural lands without reforestation) (Figure 13-1).

TABLE 13-2
FUNCTIONAL CAPACITY INDEX (FCI) EQUATIONS

Wetland Function	Equation a/
Short-term water storage (STWS)	$FCI_{STWS} = SI$
Long-term water storage (LTWS)	$FCI_{LTWS} = FCI_{STWS} \times PI$
Water velocity reduction (WVR)	$FCI_{WVR} = RI$
Sediment detention (SD)	$FCI_{SD} = FCI_{STWS} \times FCI_{WVR}$
Onsite erosion control (OSEC)	$FCI_{OSEC} = FCI_{LTWS} \times FCI_{WVR} \times DI$
Nutrient and dissolved substance removal (NDSR)	$FCI_{NDSR} = FCI_{LTWS} \times PPI \times SAI$
Organic carbon export (OCE)	$FCI_{OCE} = FCI_{STWS} \times PPI$

a/ SI = storage index; PI = ponding index; RI = roughness index; DI = disturbance index; PPI = primary productivity index; SAI = surface area index.

TABLE 13-3
FUNCTIONAL CAPACITY INDEX (FCI) VALUES FOR
FORESTED WETLANDS (FO), FARMED WETLANDS (FW) AND REFORESTATION OF
FREQUENTLY FLOODED AGRICULTURAL LAND
FOR ENVIRONMENTAL DESIGN AND COMPENSATION (AA)

Wetland Function	FCI_{FO}	FCI_{FW}	FCI_{AA}
Short-term water storage	1.00	0.50	0.45
Long-term water storage	1.00	0.25	0.68
Water velocity reduction	1.00	0.29	0.64
Sediment detention	1.00	0.14	0.77
Onsite erosion control	0.67	0.02	0.58
Nutrient and dissolved substance removal	0.67	0.06	0.55
Organic carbon export	1.00	0.33	0.60

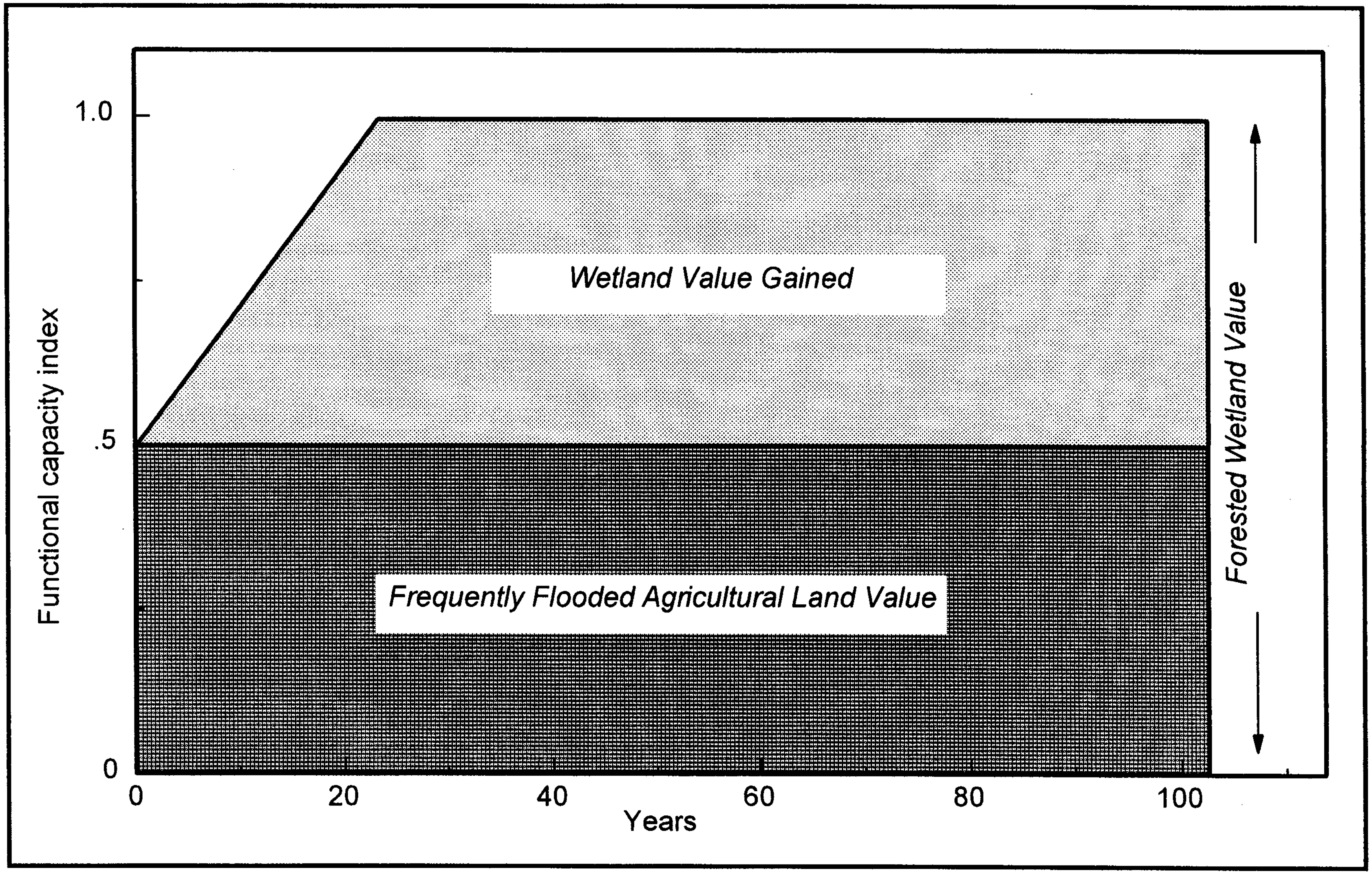

Figure 13-1. Conceptual relationship of wetland functional gain through reforestation.

FUNCTIONAL CAPACITY UNITS

28. The functional capacity of each function was the product of the FCI and wetland acreage. The product was expressed as functional capacity units (FCU's). Similar to the Habitat Evaluation Procedures, FCU's are a function of the quality and quantity of a wetland function.

29. FCU's were estimated for with- and without-project using:

$$FCUs_{Combination_x} = FCI_{Function} \times Acres_{Wetland}$$

Where: $FCUs_{Combination\,x}$ = FCU's of alternative/function/type combination *x* (e.g., without project/short-term water storage/forested).
$FCI_{Function}$ = FCI of the wetland function (e.g., short-term water storage)
$Acres_{Wetland}$ = Acres of wetland type (e.g., forested)

Net changes in FCU's were estimated using:

$$FCUs_{Combination_y} = FCUs_{With\ Project_x} - FCUs_{Without\ Project}$$

Where: $FCUs_{Combination\ y}$ = Change in FCU's for function/type combination *y* (e.g., short-term water storage/forested).
$FCUs_{With\ Project\ x}$ = Function/type FCU's for alternative *x*.
$FCUs_{Without\ Project}$ = Function/type FCU's without project.

30. All functions were considered to have equal value. Therefore, the net FCU change for forested and farmed wetlands on each alternative was determined by summing FCU's across all functions over the period of analysis. Total net FCU change for each alternative (i.e., net effect of the construction) was determined by summing the forested and farmed wetlands FCU's.

$$FCUs_{Total_c} = FCUs_{Forested} + FCUs_{Farmed}$$

Where: $FCUs_{Total\ c}$ = Total wetland FCU's for the alternative.
$FCUs_{Forested}$ = Forested FCU's for the alternative.
$FCUs_{Farmed}$ = Farmed FCU's for the alternative.

31. FCU's were annualized to account for temporal changes in with- and without-project conditions (Figure 13-2). It was assumed that existing conditions would remain constant for the project life and there would be a linear decline of FCU's during the construction period. The analysis period was 100 years. Construction was assumed to be complete in 2020 for the

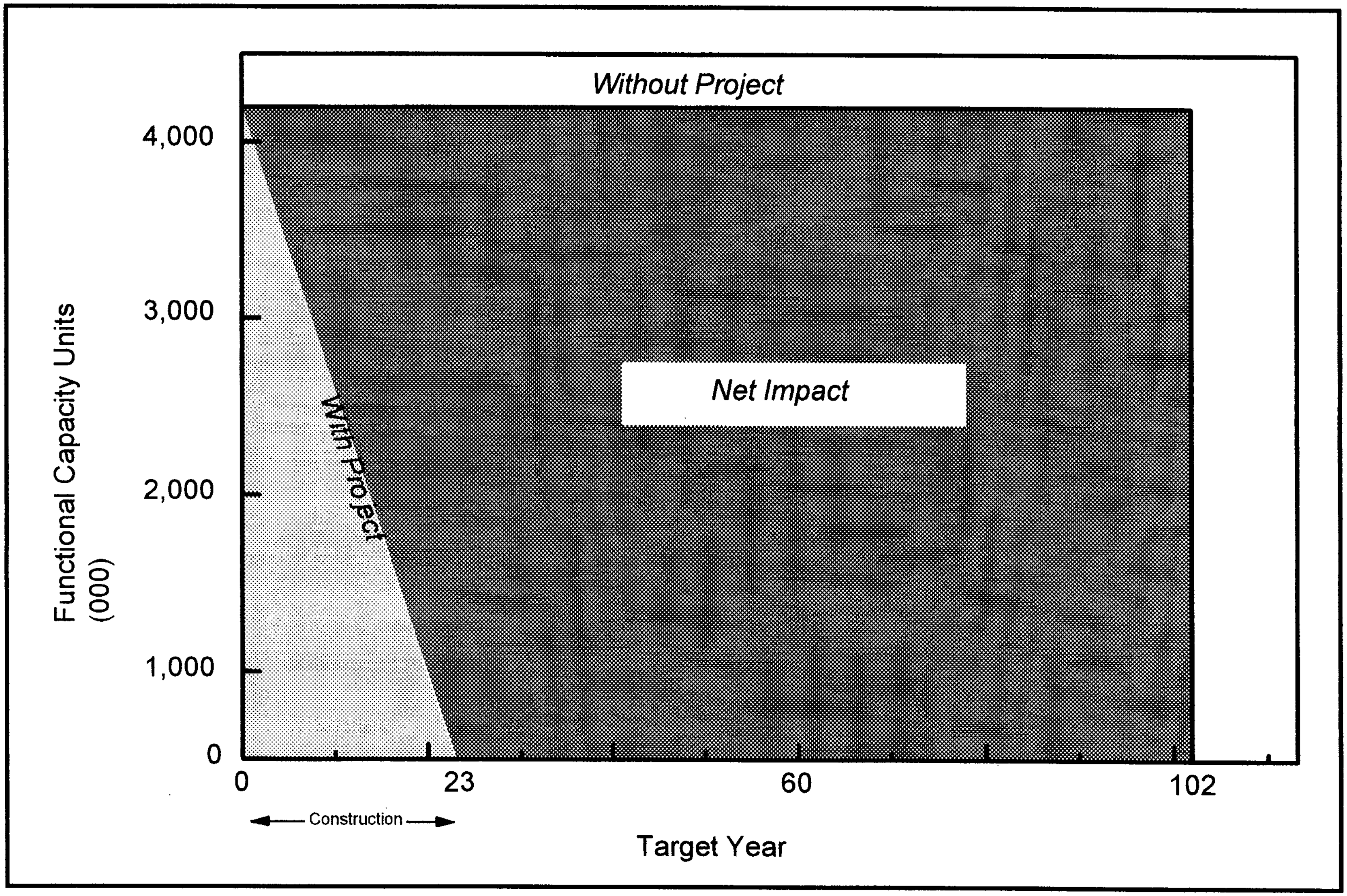

Figure 13-2. Conceptual relationship between with- and without project functional capacity units, Vicksburg District. Other districts similar, except for construction period.

Vicksburg District, 2014 for the Memphis District, and 2005 for the New Orleans District. This analysis was conducted only on those lands potentially impacted by the alternatives. Therefore, the no-action values in the "Impact Analysis" section represent the baseline wetland functional value of the lands potentially impacted by construction.

COMPENSATION AND ENVIRONMENTAL
DESIGN (REFORESTATION)

32. Compensation for unavoidable functional impacts would be accomplished through reforestation of frequently flooded agricultural lands. Reforestation of selected borrow areas would also be a project feature. Functional wetland values would occur in borrow areas which incorporate aquatic design features, but these values were not quantified. Only the net functional gain from reforesting the land was used for compensation and environmental design calculations (see Figure 13-1).

33. The FCU's for each alternative were adjusted to account for FCU's gained through environmental design (reforestation of borrow areas) using:

$$\mathbf{FCUs}_{\mathrm{Mitigate}_c} = \mathrm{FCUs}_{\mathrm{Total}_c} + \mathrm{FCUs}_{\mathrm{Gain}_c}$$

Where: $\mathrm{FCUs}_{\mathrm{Mitigate}\ c}$ = Net FCU's for determining compensation for the construction alternative
$\mathrm{FCUs}_{\mathrm{Total}\ c}$ = FCU's for the construction alternative
$\mathrm{FCUs}_{\mathrm{Gain}\ c}$ = FCU's gained from environmental design

Compensation was determined using:

$$\text{Compensation acreage} = \mathrm{FCUs}_{\mathrm{Mitigate}_c} / \sum \mathrm{FCI}_{AA}$$

Where: $\mathrm{FCUs}_{\mathrm{Mitigate}\ c}$= Total FCU's lost for the alternative.
$\sum \mathrm{FCI}_{AA}$ = Sum of reforestation FCI's.

AVOID, MINIMIZE AND ENVIRONMENTAL DESIGN MEASURES

34. Plan 4 would avoid and minimize wetland impacts to the maximum extent practicable by relocating borrow areas, using existing berm material for levee enlargement and replacing it with material dredged from the river, and using relief wells and slurry trench cutoffs in lieu of berms. Complete descriptions of relief well, slurry trench cutoffs, and dredging techniques are in the Engineering Appendix (Volume II, Appendix 6).

35. The greatest opportunity for avoiding and minimizing impacts occurred with relocating borrow areas. There was little opportunity to avoid or minimize forested wetland impacts from levee enlargement and seepage control construction because this work must occur in the area where the levee is deficient. For example, between Plans 3 and 4 there was a 20 percent reduction in levee and berm acreage classified as forested wetlands, but a 69 percent reduction in borrow area acreage.

36. Plan 4 is an environmental design which incorporates measures to avoid and minimize environmental damages to bottom-land hardwoods and wetlands. To develop the layout of the plan, interdisciplinary teams of state and Federal agencies representatives, local sponsors, and Corps staff were formed. They initially focused on relocating the construction borrow areas using the following placement prioritization criteria as a guide.

a. Landside cropland from willing sellers.

b. Landside cropland when riverside locations were unavailable.

c. Riverside prior-converted cropland.

d. Riverside tree plantations.

e. Riverside farmed wetlands (cropland).

f. Riverside farmed wetlands (pasture).

g. Riverside herbaceous wetlands.

h. Riverside forested nonwetlands.

i. Riverside forested wetlands.

j. Landside and riverside bottom-land hardwoods with black bear presence.

k. Landside cropland condemnation.

37. However, as various methods of construction were evaluated for each work item, it became apparent that the prioritization criteria could not be strictly and consistently applied to the entire Mississippi River Levees study area. For example, in the New Orleans District, the area between the top bank of the river and the levee is relatively narrow and often developed, whereas in the Vicksburg District these areas are relatively wide and undeveloped. Riverside land use in the Vicksburg District is split between cropland and forested, but in the Memphis District the riverside land use becomes predominantly cropland. Rather than apply the prioritization scheme mechanically, the study team evaluated each individual item, and applied the avoid-and-minimize techniques as was most reasonable, considering the environmental, economic, and engineering solutions available for that item.

38. Borrow areas that met the following criteria would be reforested:

a. Borrow areas greater than 125 acres for the Vicksburg District and borrow areas greater than 60 acres for the Memphis District.

b. Distance of channel work for drainage $\leq$ 2,000 feet directly connected to the Mississippi River.

c. Drainage channel avoids impacting significant acreage impacts to forested areas.

d. Proximity to forested areas.

39. Approximately 3,000 acres of borrow area with Plan 4 would be reforested (Table 13-4). The majority of reforestation would occur in Mississippi.

TABLE 13-4
REFORESTATION OF BORROW AREAS
BY STATE

State	Acres to Reforest
Arkansas	228
Illinois	0
Kentucky	0
Louisiana	643
Mississippi	1,572
Missouri	598
Tennessee	0
Total	3,041

BASELINE CONDITION

40. Impacted wetland acreage for Plan 3 represents 1.1 percent of project area wetlands and for Plan 4, 0.7 percent (Table 13-5). Forested wetlands and tree plantations account for 71 percent, and cropland and pasture 22 percent of the wetlands impacted by Plan 3. Scrub/shrub, herbaceous and marsh cover types cumulatively represent 6 percent of the impacts, and urban areas represent 1 percent. However, in Plan 4, forested wetlands and tree plantations account for only 44 percent, and cropland and pasture account for 49 percent of the wetlands impacted. Scrub/shrub, herbaceous and marsh cover types represent 6 percent of the impacts, and urban areas represent 1 percent.

TABLE 13-5
WETLAND ACREAGE IMPACTS
PROJECT TOTALS

Land Use	Wetland Acres	Plan 3 Impacts		Plan 4 Impacts	
		Acres	Percent	Acres	Percent
Forested	636,254	7,929	1.2	2,760	0.4
Cropland	231,556	2,094	0.9	3,220	1.4
Sandbar	45,600	0	0.0	13	0.0
Scrub/Shrub	43,440	406	0.9	245	0.6
Tree Plantations	22,584	331	1.5	498	2.2
Pasture	19,536	478	2.5	351	1.8
Herbaceous	11,043	289	2.6	167	1.5
Marsh	5,925	40	1.2	21	0.6
Urban/Industrial	4,594	87	1.9	65	1.4
Bare Soil	1,825	0	0.0	0	0.0
Total	1,022,357	11,654	1.1	7,340	0.7

41. The largest portion of wetland acres impacted by Plans 3 and 4 occur in the Vicksburg District (Table 13-6). Approximately 75 percent of the forested wetland impacts of Plan 3 occur in the Vicksburg District and 25 percent in the Memphis District. Approximately 93 percent of the forested wetland impacts of Plan 4 occur in the Vicksburg District and 7 percent in the Memphis District. New Orleans District accounts for less than 1 percent of the forested wetland impacts of Plans 3 and 4. About two-thirds of the farmed wetland impacts occur in the Vicksburg District for Plans 3 and 4. The New Orleans District had no farmed wetlands impacted.

TABLE 13-6
WETLAND ACREAGE IMPACTED
BY DISTRICT

District	Forested a/		Farmed b/	
	Plan 3	Plan 4	Plan 3	Plan 4
Vicksburg	6,723	3,428	1,687	2,543
Memphis	2,255	246	972	1,094
New Orleans	17	17	0	0
Total	8,995	3,691	2,659	3,637

a/ Includes forested, tree plantations, scrub/shrub (3 percent), herbaceous (2 percent), and marsh (0.3 percent) cover types.
b/ Includes cropland, pasture, and urban cover types.

42. Louisiana and Mississippi have the largest number of wetlands impacted by Plans 3 and 4, accounting for 72 percent of Plan 3 impacts and 77 percent of Plan 4 impacts (Table 13-7). Illinois, Kentucky, and Tennessee have the smallest acreage impacts, each having less than 130 wetland acres impacted by Plan 3 and less than 75 acres by Plan 4.

TABLE 13-7
WETLAND ACREAGE IMPACTED
BY STATE

State	Forested a/		Farmed b/	
	Plan 3	Plan 4	Plan 3	Plan 4
Arkansas	1,150	166	199	411
Illinois	43	29	39	42
Kentucky	110	0	19	0
Louisiana	3,227	1,816	868	1,378
Mississippi	3,477	1,493	786	925
Missouri	963	187	714	853
Tennessee	25	0	34	28
Total	8,995	3,691	2,659	3,637

a/ Includes forested, tree plantations, scrub/shrub (3 percent), herbaceous (2 percent), and marsh (0.3 percent) cover types.
b/ Includes cropland, pasture, and urban cover types.

43. Ninety percent of the impacted wetlands for Plans 3 and 4 occur riverside of the levee (Table 13-8). Eighty percent of the impacted riverside wetlands in Plan 3 is forested, and 50 percent in Plan 4 is forested. About 50 percent of the impacted wetlands landside of the levee for Plans 3 and 4 is forested.

TABLE 13-8
IMPACTED WETLAND ACREAGE
RIVERSIDE AND LANDSIDE DISTRIBUTION

Alternative	Riverside		Landside	
	Forested a/	Farmed b/	Forested	Farmed
Vicksburg District				
Plan 3	6,401	1,409	322	278
Plan 4	3,138	2,292	290	251
Memphis District				
Plan 3	2,022	681	233	291
Plan 4	148	952	98	142
New Orleans District				
Plan 3	17	0	0	0
Plan 4	17	0	0	0
Total				
Plan 3	8,440	2,090	555	569
Plan 4	3,303	3,244	388	393

a/ Includes forested, tree plantations, scrub/shrub (3 percent), herbaceous (2 percent), and marsh (0.3 percent) cover types.
b/ Includes cropland, pasture, and urban cover types.

44. Approximately 73 percent of the average annual functional capacity unit (AAFCU) loss would occur within the Vicksburg District for Plan 3 (Table 13-9). Eighty-nine percent of the Plan 4 AAFCU loss would occur in the Vicksburg District. There was no practical opportunity to avoid or minimize impacts in the New Orleans District other than utilization of totally landside borrow; therefore, the impacts of both plans are identical. Forested wetlands account for 94 percent of the AAFCU loss under Plan 3 and 83 percent under Plan 4. Plan 3 would double the AAFCU loss of Plan 4.

TABLE 13-9
WETLAND FUNCTIONAL ANALYSIS
BY DISTRICT a/

Alternative	Average Annual Functional Capacity Units (AAFCU's)						
	No-action		Future with action Construction b/		Net Change c/		Total Net Change
	FO	FW	FO	FW	FO	FW	
Vicksburg District							
Plan 3	42,604	2,171	4,803	245	-37,801	-1,926	-39,727
Plan 4	21,746	3,280	2,451	369	-19,295	-2,911	-22,206
Memphis District							
Plan 3	14,290	1,254	1,190	107	-13,100	-1,147	-14,247
Plan 4	1,566	1,408	130	116	-1,436	-1,292	-2,728
New Orleans District							
Plan 3	105	0	4	0	-101	0	-101
Plan 4	105	0	4	0	-101	0	-101
Total							
Plan 3	56,999	3,425	5,997	352	-51,002	-3,073	-54,075
Plan 4	23,417	4,688	2,585	485	-20,832	-4,203	-25,035

a/ FO = forested wetland; FW = farmed wetland.
b/ AAFCU value of impacted lands after construction.
c/ Future with action AAFCU's minus no-action AAFCU's.

45. Plans 3 and 4 would result in an AAFCU loss in Arkansas (Table 13-10). Approximately 50 percent of the Plan 3 AAFCU loss in Arkansas would occur in the Vicksburg District and 50 percent in the Memphis District. Eighty-two percent of the Plan 4 AAFCU loss would occur in the Vicksburg District. Forested wetlands account for 97 percent of the AAFCU loss under Plan 3, but only 66 percent under Plan 4. Thirteen percent of the total wetland impacts of Plan 3 would occur in Arkansas, and 6 percent of Plan 4 impacts would occur in Arkansas.

TABLE 13-10
WETLAND FUNCTIONAL ANALYSIS
STATE OF ARKANSAS a/

Alternative	Average Annual Functional Capacity Units (AAFCU's)						
	No-action		Future with action Construction b/		Net Change c/		Total Net Change
	FO	FW	FO	FW	FO	FW	
Vicksburg District							
Plan 3	3,905	182	440	21	-3,465	-161	-3,626
Plan 4	970	338	109	38	-861	-300	-1,161
Memphis District							
Plan 3	3,379	74	281	7	-3,098	-67	-3,165
Plan 4	82	192	6	16	-76	-176	-252
Total							
Plan 3	7,284	256	721	28	-6,563	-228	-6,791
Plan 4	1,052	530	115	54	-937	-476	-1,413

a/ FO = forested wetland; FW = farmed wetland.
b/ AAFCU value of impacted lands after construction.
c/ Future with action AAFCU's minus no-action AAFCU's.

46. Plans 3 and 4 would result in an AAFCU loss in Louisiana (Table 13-11). Almost the entire AAFCU loss of both plans in Louisiana would occur in the Vicksburg District. Forested wetlands account for 95 percent of the AAFCU loss under Plan 3 and 87 percent under Plan 4. Thirty-five percent of the total wetland impacts of Plan 3 would occur in Louisiana, and 47 percent of Plan 4 impacts would occur in Louisiana.

TABLE 13-11
WETLAND FUNCTIONAL ANALYSIS
STATE OF LOUISIANA a/

Alternative	Average Annual Functional Capacity Units (AAFCU's)						
	No-action		Future with action Construction b/		Net Change c/		Total Net Change
	FO	FW	FO	FW	FO	FW	
Vicksburg District							
Plan 3	20,345	1,117	2,294	126	-18,051	-991	-19,042
Plan 4	11,418	1,776	1,287	200	-10,131	-1,576	-11,707
New Orleans District							
Plan 3	105	0	4	0	-101	0	-101
Plan 4	105	0	4	0	-101	0	-101
Total							
Plan 3	20,450	1,117	2,298	126	-18,152	-991	-19,143
Plan 4	11,523	1,776	1,291	200	-10,232	-1,576	-11,808

a/ FO = forested wetland; FW = farmed wetland.
b/ AAFCU value of impacted lands after construction.
c/ Future with action AAFCU's minus no-action AAFCU's.

47. Plans 3 and 4 would result in an AAFCU loss in Mississippi (Table 13-12). The majority of the AAFCU loss of both plans in Mississippi would occur in the Vicksburg District. Forested wetlands account for 96 percent of the AAFCU loss under Plan 3 and 89 percent under Plan 4. Thirty-eight percent of the total wetland impacts of Plan 3 and Plan 4 would occur in Mississippi.

TABLE 13-12
WETLAND FUNCTIONAL ANALYSIS
STATE OF MISSISSIPPI a/

Alternative	Average Annual Functional Capacity Units (AAFCU's)						
	No-action		Future with action Construction b/		Net Change c/		Total Net Change
	FO	FW	FO	FW	FO	FW	
Vicksburg District							
Plan 3	18,354	872	2,069	98	-16,285	-774	-17,059
Plan 4	9,358	1,166	1,055	131	-8,303	-1,035	-9,338
Memphis District							
Plan 3	3,684	141	307	12	-3,377	-129	-3,506
Plan 4	114	26	10	2	-104	-24	-128
Total							
Plan 3	22,038	1,013	2,376	110	-19,662	-903	-20,565
Plan 4	9,472	1,192	1,065	133	-8,407	-1,059	-9,466

a/ FO = forested wetland; FW = farmed wetland.
b/ AAFCU value of impacted lands after construction.
c/ Future with action AAFCU's minus no-action AAFCU's.

48. Plan 3 would result in an AAFCU loss in Illinois, Kentucky, Missouri, and Tennessee (Table 13-13). Plan 4 would result in an AAFCU loss in Illinois, Tennessee, and Missouri, and no impact in Kentucky. All of these net changes would occur in the Memphis District. Plan 3 in all states would result in a loss of forested wetland AAFCU's, and Plan 4 would result in a loss of forested wetland in Illinois and Missouri. Fourteen percent of the total wetland impacts of Plan 3 would occur in these states, and 9 percent of Plan 4 impacts would occur in these states.

TABLE 13-13
WETLAND FUNCTIONAL ANALYSIS
STATES OF ILLINOIS, KENTUCKY, MISSOURI, AND TENNESSEE a/

Alternative	Average Annual Functional Capacity Units (AAFCU's)						
	No-action		Future with action Construction b/		Net Change c/		Total Net Change
	FO	FW	FO	FW	FO	FW	
Illinois							
Plan 3	273	50	23	4	-250	-46	-296
Plan 4	184	54	15	4	-169	-50	-219
Kentucky							
Plan 3	697	25	58	3	-639	-22	-661
Plan 4	0	0	0	0	0	0	0
Missouri							
Plan 3	6,099	920	508	77	-5,591	-843	-6,434
Plan 4	1,186	1,100	99	91	-1,087	-1,009	-2,096
Tennessee							
Plan 3	158	44	13	4	-145	-40	-185
Plan 4	0	36	0	3	0	-33	-33

a/ Memphis District only; FO = forested wetland; FW = farmed wetland.
b/ AAFCU value of impacted lands after construction.
c/ Future with action AAFCU's minus no-action AAFCU's.

49. A summary and comparison of AAFCU's and wetland acres impacted without environmental design or compensation are presented in Table 13-14. Plan 3 results in a 4.6 AAFCU loss per acre, and Plan 4 results in a 3.4 AAFCU loss per acre.

TABLE 13-14
COMPARISON OF AAFCU'S AND WETLAND ACRES IMPACTED
WITHOUT ENVIRONMENTAL DESIGN OR COMPENSATION

District	Plan 3		Plan 4	
	AAFCU's	Acres a/	AAFCU's	Acres a/
Vicksburg	-39,727	8,410	-22,206	-5,971
Memphis	-14,247	3,227	-2,728	1,340
New Orleans	-101	17	-101	17
Project Total	-54,075	11,654	-25,035	7,328

a/ Includes all wetlands.

ENVIRONMENTAL DESIGN

50. Wetland benefits of reforesting approximately 3,000 acres of borrow area are presented in Table 13-15. These benefits are in addition to compensation measures.

TABLE 13-15
BORROW AREA REFORESTATION BENEFITS

District	Acres	AAFCU's
Vicksburg	2,366	+10,103
Memphis	675	+2,882
New Orleans	0	0
Total	3,041	+12,985

MITIGATION ANALYSIS

51. Compared to Plan 3, a 54 percent reduction in the loss of AAFCU's would be achieved through the use of avoid- and-minimize techniques in Plan 4 (Table 13-16). Relocating borrow areas and the use of relief wells, slurry trench cutoffs, and dredging would result in a 44 percent reduction in the AAFCU loss in the Vicksburg District and an 81 percent reduction in the Memphis District.

TABLE 13-16
AVOID-AND-MINIMIZE ANALYSIS
BY DISTRICT

Wetland	Impact (AAFCU's) a/		Change (%)
	Plan 3	Plan 4	
Vicksburg District			
Forested	-37,801	-19,295	-49
Farmed	-1,926	-2,911	51
Total	-39,727	-22,206	-44
Memphis District			
Forested	-13,100	-1,436	-91
Farmed	-1,147	-1,292	1
Total	-14,247	-2,728	-81
New Orleans District			
Forested	-101	-101	0
Farmed	0	0	0
Total	-101	-101	0
All Districts			
Total	-54,075	-25,035	-54

a/ Plan 4 includes avoid-and-minimize actions (borrow area relocation, etc.).

52. Plan 3 does not include compensation for unavoidable wetland functional value. Plan 4 would result in an unavoidable loss of 25,035 AAFCU's after incorporation of the avoid-and-minimize techniques. Reforestation of 5,863 acres of frequently flooded agricultural lands (25,035 AAFCU's/4.27 AAFCU's per acre of reforestation; see Compensation and Environmental Design Section) would be necessary to achieve a no-net-loss of wetland functional value (Table 13-17). This compensatory mitigation combined with reforestation of borrow areas produces a net gain in wetland functional value.

TABLE 13-17
COMPENSATION FOR UNAVOIDABLE
IMPACTS OF PLAN 4 BY DISTRICT

District	Net Change (AAFCU's)	Compensation (acres)
Vicksburg	-22,206	5,200
Memphis	-2,728	639
New Orleans	-101	24
Project Total	25,035	5,863

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ATTACHMENT 1
WETLAND DELINEATION

ATTACHMENT 1
WETLAND DELINEATION

Purpose. To describe procedures for identifying the extent of Federal regulatory jurisdiction pursuant to Section 404 of the Clean Water Act for the Mainline Mississippi River Levees project.

Project Boundary. The project boundary for the jurisdictional determination includes all lands riverward of the landside toe of the mainline Mississippi River levee (on both sides) from near Cape Girardeau, Missouri, to Head of Passes in the New Orleans District. This area is generally referred to as the batture land. The jurisdictional determination will also include an area 3,000 feet landward of the landside toe of the existing levee system. Where no levee system exists, the project area extends from the Mississippi River landward to apparent upland areas (e.g., hill line) or to the lateral extent of the Mississippi River flood plain, whichever is greater. In areas where the flood plain is extensive (coastal areas), the area of consideration will extend 1 mile either side of the centerline of the channel.

Procedure. The 1987 U.S. Army Corps of Engineers Wetlands Delineation Manual with supplemental guidance was used as the basis for determining the extent of jurisdictional wetlands for vegetated areas within the project boundary. Other regulated waters of the United States; e.g., rivers, lakes and streams, were also identified as jurisdictional. Wetlands on agricultural lands were identified using procedures in the National Food Security Act Manual (3rd Edition). Due to the magnitude of the area to be delineated, offsite procedures of the appropriate manual were used to establish the approximate extent of jurisdiction. Delineators consulted with the Natural Resources Conservation Service for the offsite jurisdictional determination on agricultural lands. Available offsite information was entered into a geographic information systems (GIS) data base and used to assess the wetland characteristics of vegetation, soils, and hydrology. The GIS was then used to produce preliminary jurisdictional maps which were ground truthed by an interagency team.

Assumptions. Because of the extensive area covered by the jurisdictional determination, certain assumptions were made about vegetation, soils, and hydrology based upon preliminary field investigations and available statistical data. These assumptions were then applied to the entire reach. The following is a summary of key assumptions:

a. Vegetation. An existing GIS data base characterizing vegetative cover and land use over a large portion of the project area was used as a primary tool for assessing wetland vegetation. Based on hydrology data, landscape position, soil survey data, and best professional judgment, it was assumed that those areas with dominant Facultative plants were primarily occupying nonwetland areas whereas Facultative Wetland and Obligate plants were assumed to be occupying wetland areas. This assumption was supported by those individuals familiar with the distribution of species in the batture area and by guidance in the 1987 manual which cautions users that Facultative dominated plant communities may not meet wetland hydrology criteria.

b. Soils. Mapped areas with soils on the local hydric soils list were assumed to meet the hydric soils criterion. Areas with nonhydric soils and those with hydric inclusions were generally considered to be nonwetlands, although an attempt was made to identify inclusions from the offsite data available; e.g., topographical maps, aerial photography, etc.

c. Hydrology. According to the Corps 1987 manual, the upper limit of jurisdictional wetlands meeting wetland hydrology are those areas which are flooded, ponded, or saturated for 5 percent of the growing season in most years. Elevations correlating to this criterion were calculated from existing gage data and entered into a GIS data base from satellite imagery depicting a flood event correlating to hydrological conditions matching the upper limit of wetland hydrology. In addition, areas beyond the limit of flooding/ponding which were believed to meet wetland hydrology from saturation were analyzed separately by interpreting landscape position, vegetative cover, and soils. Areas believed to meet wetland hydrology from saturation alone were then added to the preliminary jurisdictional map. These areas were assumed to meet wetland hydrology.

Results. Once all data were entered into the GIS data base, preliminary maps were prepared depicting the approximate extent of jurisdictional areas as well as other pertinent information needed for the environmental analysis; e.g., land use, vegetative cover, project features, etc. The preliminary maps were then ground truthed by an interagency team to determine if the maps were suitable for planning or if adjustments needed to be made. The group confirmed earlier assumptions about each parameter and made further recommendations concerning saturated areas. Lands believed to be jurisdictional because of saturation were added to the preliminary jurisdictional map. After these corrections, the group confirmed that the maps were suitable for planning and employing avoidance and minimization techniques for project design. The maps are not intended for regulatory use. The limit of jurisdiction for future projects will be verified by appropriate procedures in the 1987 Corps of Engineers Wetland Delineation Manual to include onsite investigation if necessary.

Interagency Review. The process and assumptions developed for identifying jurisdictional areas for this project was reviewed and validated by an interagency team consisting of representatives from the U.S. Fish and Wildlife Service; Environmental Protection Agency; Natural Resources Conservation Service; U. S. Army Corps of Engineers; state Departments of Environmental Quality; Game and Fish; private landowners; levee boards; and the Sierra Club. This same team conducted a field review of the preliminary jurisdictional maps.

APPENDIX 14
BATS

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 14
BATS

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ABSTRACT

An analysis consisting of available life history and habitat data on 14 species of bats was used to assess the impacts of two structural plans to enlarge the mainline Mississippi River levees and control seepage within the U.S. Army Corps of Engineer Districts, Memphis, Vicksburg, and New Orleans. A no-action and nonstructural alternative were considered and deemed nonviable during the planning process.

The project area includes all lands and waters between the Mississippi River levees, including 3,000 feet landside beginning at Cape Girardeau, Missouri, and extending downstream to the Head of Passes, Louisiana (see Project Report). It also includes some related works in the Memphis District.

This evaluation includes all remaining levee enlargement and seepage construction works. Since the project life is 100 years, a 100-year period of analysis was used in this assessment.

Impacts of the two structural plans studied in detail were assessed and range from very minor to minor for conditions, without and with compensation measures.

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
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INTRODUCTION

BACKGROUND AND OBJECTIVES

1. Following the tremendous flood of 1927, Congress passed a Flood Control Act committing the Federal Government to a comprehensive program of flood control and authorized the Mississippi River and Tributaries Project (MR&T). The project is designed to control a "project flood" with a discharge of 3 million cubic feet per second in the alluvial valley of the lower Mississippi River (U.S. Army Corps of Engineers, 1987).

2. A major flood occurred on the lower Mississippi River in 1973. Although still incomplete, the MR&T project for flood control performed well during this flood. However, as the flood developed and stage-discharge relation data were collected and analyzed, it became apparent that the channel capacity of the lower Mississippi River had seriously deteriorated. A new design flood flow line was established, and it demonstrated the need to raise many miles of levees to provide protection against the project flood (U.S. Army Corps of Engineers, 1973). The needed levee enlargement began in 1973 and could be completed by the year 2020. This appendix contains an evaluation of the effects of alternative plans to enlarge the levees and also some measures to control seepage under the levees in the U.S. Army Corps of Engineer Districts, Memphis, Vicksburg, and New Orleans. These measures include construction of relief wells, slurry trench cutoffs, earthen berms, and also some wave water protection in the Memphis District. Construction features in the Vicksburg District include the construction of earthen berms, relief wells, and levee enlargement. Work in the New Orleans District consists of levee enlargement and paving.

PROJECT AREA AND METHODS

3. This analysis was conducted by staff biologists of the Memphis, Vicksburg, and New Orleans Districts.

PROJECT AREA

4. The Mississippi River Levees project area consists of all lands and waters between the mainline Mississippi River levees and the lands and waters within 3,000 feet landside of the landside toe of the levees in each District. Table 14-1 displays existing land use for the entire project area. (The shaded lands provide bat habitat that would change as a result of this project. Only these lands have been used in this analysis.) The project area is depicted in a series of Geographic Information System (GIS) maps located in Appendix 4. These maps show the location of each work item and the types of lands, waters, or habitat that would be affected by the two structural plans being evaluated in detail.

TABLE 14-1
PROJECT AREA LAND USE ACREAGE

Land Use	Nonwetland	Wetland	Total
Forested	385,456	636,254	1,021,710
Cropland	537,704	231,556	769,260
Urban/Industrial	71,570	4,594	76,164
Scrub/Shrub	23,939	43,440	67,379
Tree Plantations	27,887	22,584	50,471
Sandbar	3,790	45,600 a/	49,390
Pasture	22,854	19,536	42,390
Levee	26,990		26,990
Herbaceous	3,469	11,043	14,512
Marsh		5,925	5,925
Bare Soil	1,742	1,825	3,567
Subtotal	1,105,401	1,022,357	2,127,758
Open Water			518,086
Total			2,645,844

a/ Jurisdictional (regulated) water of the United States, buy may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

PROJECT ALTERNATIVES

NO-ACTION ALTERNATIVE

5. No new construction; i.e., seepage control, frontal protection, and levee height increases, only normal maintenance, repair, and replacement would be done. Thus, existing levees, berms, and floodways would remain in place as the only flood protection. Therefore, the threat of catastrophic flooding would continue. Local levee boards and the Corps would continue to expend funds in flood-fight efforts, including temporarily raising levee reaches and sandbagging sand boils.

6. As part of a report prepared in FY 97 at the direction of the U.S. Senate, limited studies were conducted to determine the expected damages from crevasses in the Mississippi River mainline levees at Mayersville, Mississippi, and Lake Providence, Louisiana. These investigations provide an indication of how catastrophic the impacts from a levee failure would be to the rest of the study area.

7. Crevasses near the small towns of Mayersville and Lake Providence, located in the central Delta region, would cause catastrophic flooding over approximately 25,000 square miles, directly affecting approximately 114,000 people, 40,000 residences, and 1,600 businesses in 12 counties and parishes along the river. Plate 47 (Appendix 4) shows the flood plain area that would be inundated with a levee failure at Lake Providence, Louisiana, and Plate 48 (Appendix 4) illustrates the alluvial area that would be inundated with a levee crevasse at Mayersville, Mississippi. Results of damage analyses indicate levee crevasses could potentially cause direct flood damages approaching $5.0 billion--almost $2.0 billion in the areas along the east bank of the Mississippi River and $3.0 billion on the west bank.

8. A summary of flood damages/losses is depicted in Table 14-2.

TABLE 14-2
LEVEE CREVASSE AT MAYERSVILLE, MISSISSIPPI,
AND LAKE PROVIDENCE, LOUISIANA
SUMMARY OF FLOOD DAMAGES/LOSSES
($000)

Damage/Loss Category	Lake Providence Levee Crevasse	Mayersville Levee Crevasse	Total Damages/Losses
Structure Damages	1,139,746	426,264	1,566,010
Business Losses	1,031,039	569,989	1,601,028
Public Utilities	79,782	29,838	109,620
Road and Bridge Damages	22,809	8,365	31,174
Agricultural Losses	447,144	468,247	915,391
Noncrop Damages	60,823	37,846	98,669
Traffic Rerouting	72,162	3,604	75,766
Emergency Costs	50,403	39,840	90,243
Evacuation and Subsistence Costs	26,821	21,200	48,021
Reoccupation Costs	42,471	33,570	76,041
TOTALS	2,973,200	1,638,763	4,611,963

9. Since the no-action alternative would not provide protection from the Project Design Flood (PDF) and is unacceptable to Congress and the general public and thus unimplementable, no further consideration was given to the no-action option.

PLAN 1 - NONSTRUCTURAL ALTERNATIVE

10. Plan 1 represents a nonstructural option to structural flood damage reduction. Basically, only two types of practicable nonstructural measures for flood protection exist--those which reduce existing damages and those which reimburse for existing damages and reduce future damage potential. Those nonstructural measures which reduce damages were not applicable to

levee overtopping and catastrophic levee failure. The nonstructural measure which compensates or reimburses for existing damages that was addressed was purchasing easements in lieu of providing flood protection from the PDF. Existing levee protection would be maintained as in the no-action alternative. However, should the levee be overtopped and catastrophic levee failure occur, the levee would not be reconstructed.

11. Again, considering only the aforementioned Mississippi River levees breaks at Lake Providence and Mayersville, purchase of flowage easements could be required on approximately 16 million acres. Assuming only a nominal cost per acre would yield a cost in the multibillion dollar range for this single component of this isolated event. Emergency disaster activities, traffic rerouting, and road and bridge structure and public utilities damages would also be overwhelmingly costly. In view of the magnitude of these costs, no attempt was made to estimate real estate acquisition costs, Public Law 91-646 costs, and expenses associated with acquiring any improvements that would be damaged by flooding nor were provisions made to accommodate such factors as farm program disaster payments. This was unnecessary since easements would be purchased only from willing sellers and "at-risk" activities would be allowed to continue on easement lands.

12. Additional long-term major maintenance costs would be expected to be incurred during the remaining economic life of the project. However, neither the economic aspects of anticipated future levees rehabilitation due to crevasses, nor additional augmentation of the easement area as unforeseen levee breaks occurred were calculated. Over time, more acreage could become subject to flooding. Additional easements would have to be acquired, and potentially some lands previously encumbered could require increased easement payments for more frequent flooding incurred due to upstream levee failures, which would be impossible to predict.

13. Nonstructural alternatives such as acquisition of flowage easements can be utilized only if they further a project purpose or there is some legal obligation for them. Flowage easements were considered as a substitute for provision of PDF protection through levee raising. Such an alternative would not accomplish the congressionally mandated project purpose to provide a prescribed level of flood protection. In view of this and considering the prohibitive implementation and continuing costs and certain public unacceptability, a nonstructural plan would not be implementable. It was given no additional consideration.

STRUCTURAL ALTERNATIVES

14. Three structural alternatives were addressed in the preliminary screening-- Plan 2, landside borrow; Plan 3, traditional method (riverside borrow); and Plan 4, environmental design (avoid and minimize) to construct levee enlargement and seepage control.

Plan 2 - Landside Borrow

15. This alternative presumes continuing construction of levee enlargement and raising, seepage control, and frontal protection. All borrow material would be obtained from landside of the levee. Three landside borrow schemes were investigated:

a. Plan 2A - Traditional landside borrow.

(1) Plan 2A consists of purchasing rights-of-way for traditional rectangular borrow areas 8 to 10 feet deep in a band 2,000 to 3,000 feet from the landside toe of the levee where feasible (see Plate 49, Appendix 4). A minimum distance of 2,000 feet from the landside levee toe to the closest borrow area is required to prevent underseepage problems and a maximum of 3,000 feet from the landside levee toe was used as the outer limit on the distance to haul borrow for levee and berm construction.

(2) Suitable material would be excavated and used to enlarge the levee as shown on Plate 49 (Appendix 4) or to construct berms. The landside rights-of-way would be expensive. The extended borrow haul distance would also increase costs.

(3) Water quality in the landside borrow areas would likely be poor due to runoff from adjacent agricultural fields. The runoff would carry high loads of suspended sediments, nutrients, and organochlorine pesticides. Existing landside borrow areas have high levels of DDE. Fish tissue levels of DDE from samples acquired as a part of these studies approach the FDA action levels for fish consumption and are two orders of magnitude above the no observable effects level for these pesticides.

b. Plan 2B - Traditional landside borrow with forested buffer.

(1) This alternative consists of a deep (average 8 feet) borrow area which would be protected by a forested buffer zone approximately equal in area to the borrow, with a protective berm around the outside of the buffer to prevent chemicals from entering the borrow area (see Plate 50, Appendix 4). As in Plan 2A, the required location for the borrow area is 2,000 to 3,000 feet landside of the levee toe.

(2) Plate 50 (Appendix 4) shows the excavated borrow area with the material used to enlarge the levee. The forested buffer area and protective dike are shown on the borrow area periphery. This design would isolate the borrow from the local drainage which carries pesticides, thereby improving water quality. However, this requires additional cost for engineering and design and lands and damages.

c. Plan 2C - Landside shallow borrow. Landside shallow borrow allows for draining the borrow area so that it can be forested. Borrow excavation is limited to 3 feet deep and shaped to drain and connect to local drainage, thereby providing habitat for tree growth. As in the previous landside borrow areas, the required location is in a band 2,000 to 3,000 feet from the landside toe of the levee. Plate 51 (Appendix 4) shows a typical layout of borrow area location, excavation and levee enlargement, and forested borrow. This shallow borrow greatly expands the required borrow area acreage, increasing lands and damages costs commensurately.

Plan 3 - Traditional Method

16. Plan 3 is the traditional historical method to construct levee enlargements and berms. New and innovative designs to reduce the cross-sectional area of the levees have been incorporated and, where possible, the levee enlargement is located to the side requiring the least amount of material.

17. The borrow areas are normally located riverside as close to the construction site as engineeringly feasible (proper soil for levee embankment) and excavated as deep as soil layers will allow (see Plate 52, Appendix 4). This plan requires no special configuration or location of the borrow areas other than for engineering purposes. No provisions are made for drainage or environmental enhancement of the borrow areas. However, past experience has shown that a majority of the resulting borrow areas permanently hold water which is replenished or "flushed" periodically by normal river fluctuations.

18. The traditional method analysis consisted first of printing GIS maps that contain the following data layers: base topographic features, land cover mapping, jurisdictional wetland mapping, and items of work. The items of work layer included enlargement footprints, berm footprints, and original borrow areas. To develop the layout of the plan described as Plan 3, the engineering design team located the borrow areas for the traditional method on the items of work mapping layer.

Plan 4 - Environmental Design (Avoid-and-Minimize)

19. Plan 4 is an environmental design which incorporates measures to avoid and minimize environmental damages to bottom-land hardwoods and wetlands. To develop the layout of the plan, interdisciplinary teams of state and Federal agencies representatives, local sponsors, and Corps staff were formed. They initially focused on relocating the construction borrow areas using the following placement prioritization criteria as a guide.

a. Landside cropland from willing sellers.

b. Landside cropland when riverside locations were unavailable.

c. Riverside prior-converted cropland.

d. Riverside tree plantations.

e. Riverside farmed wetlands (cropland).

f. Riverside farmed wetlands (pasture).

g. Riverside herbaceous wetlands.

h. Riverside forested nonwetland.

i. Riverside forested wetland.

j. Landside and riverside bottom-land hardwoods with black bear presence.

k. Landside cropland condemnation.

20. However, as various methods of construction were evaluated for each work item, it became apparent that the prioritization criteria could not be strictly and consistently applied to the entire MRL study area. For example, in the New Orleans District, the area between the top bank of the river and the levee is relatively narrow and often developed, whereas in the Vicksburg District, these areas are relatively wide and undeveloped. Riverside land use in the Vicksburg District is

split between cropland and forested, but in the Memphis District, the riverside land use becomes predominantly cropland. Rather than apply the prioritization scheme mechanically, the study team evaluated each individual item and applied the avoid-and-minimize techniques as was most reasonable, considering the environmental, economic, and engineering solutions available for that item.

21. The teams also considered other innovative design approaches for reducing bottom-land hardwoods and wetlands effects. When environmentally, economically, and engineeringly feasible, existing berm material may be used to enlarge the levee (see Plate 53, Appendix 4) and replace the excavated berm with material dredged from the river (see Plates 54 and 55, Appendix 4). As shown on Plate 54, the only environmental loss would be temporary and comprised of a narrow path in which to lay the dredge pipe from the river to the berm site while pumping dredged material. Plate 29, Appendix 4, shows the locations of work items 498.0-L, 497.0-L, 495.0-L, and 493.0-L (these four items have been combined and renamed work item 496.0-L) and the dredge site locations in the Mississippi River to be used for borrow to construct these work items. The use of relief wells or cutoff trenches to control seepage instead of berms could be used if engineeringly and environmentally feasible. The relief wells or cutoff trenches would only temporarily affect the environment during construction.

Structural Alternatives Screening

22. The structural alternatives were screened to determine the most viable and implementable plans (see Project Report). Plans 3 and 4 were selected, carried forward into design, and evaluated in detail.

EVALUATION SPECIES

23. Impacts to habitat of the following 14 species of bats were assessed in this analysis.

Little Brown Myotis (Myotis lucifugus)
Southeastern Myotis (Myotis austroriparius)
Northern Long-eared Myotis (Myotis septentrionalis)
Eastern small-footed bat (Myotis leibii)
Eastern Pipistrelle (Pipistrellus subflavus)
Big Brown Bat (Eptesicus fuscus)
Rafinesques Big-eared Bat (Plecotus rafinesquii)
Eastern Red Bat (Lasiurus borealis)
Seminole Bat (Lasiurus seminolus)
Hoary Bat (Lasiurus cinereus)
Northern Yellow Bat (Lasiurus intermedius)
Silver-haired Bat (Lasionycteris noctivagans)
Evening Bat (Nycticeius humeralis)
Brazialian Free-tailed Bat (Tadarida brasiliensis)

ENDANGERED OR THREATENED SPECIES

24. No endangered or threatened species of bats are likely to be present in the project area. Two such species--the gray bat (Myotis grisescens) and the Indiana bat (Myotis sodalis)--occur closest to the project area. However, it is unlikely that either of these two species utilize the area due to lack of habitat.

GENERALIZED LIFE HISTORY OF BATS

25. While there are differences in the life histories of the evaluation species, this section contains pertinent data concerning behaviors collectively of the bats used in this analysis (Burt and Grossenheider, 1964; Caras, 1967; Chapman and Feidhamer, 1982; Choate, Jones, and Jones, 1994; Harvey, 1992; Humphrey, 1982; and Lowery, 1974). These bats are nocturnal and venture out of daytime roosts when the weather is warm enough to feed in the evening, or night, on insects. Roosts that can be used include such places as crevices, buildings, garages, culverts, bridges, hollow trees, foliage of trees, loose bark on trees, and Spanish moss. Feeding areas can include areas above ponds and streams, areas near treetop level at the forest edge, zones among the canopy, and over clearings. Some species may migrate from north to south in the fall and hibernate in suitable retreats. Species in the southern part of their ranges can occasionally venture out on mild winter days. Young are usually born from late April to early June. Predators on bats can include such species as opossums, snakes, owls, and predatory birds.

BASELINE HABITAT CONDITIONS

26. There are considerably more forested land and aquatic areas on the riverside of the levees. Consequently, species that utilize forested areas for roosting and feeding and aquatic areas for feeding would be expected to be more numerous on this side. The landside levees in the project area have considerably more cleared land and less aquatic areas than the riverside. Species that feed in cleared areas find more opportunities to feed more frequently on the landside.

27. Habitat acreage under existing conditions and with each plan is given in Table 14-3. This table does not reflect the effects of compensatory mitigation measures. Acreage shown for Plans 3 and 4 would exist at the completion of the project.

TABLE 14-3
HABITAT ACREAGE FOR EXISTING CONDITIONS
AND PLAN 3 AND PLAN 4

Habitat Type	Existing Conditions	Plan 3	Plan 4
Memphis District			
Cleared Land a/	502,146	498,539	499,292
Open Water b/	1,340	1,340	1,400
Woodlands c/	381,257	378,179	381,771
Vicksburg District			
Cleared Land	286,792	284,176	279,369
Open Water	5,794	17,594	12,444
Woodlands	552,350	543,225	546,934

TABLE 14-3 (Cont)

Habitat Type	Existing Conditions	Plan 3	Plan 4
New Orleans District			
Cleared Land	99,935	99,935	99,935
Open Water	2,939	2,956	2,956
Woodlands	138,574	138,557	138,557

a/ Agricultural, pasture, herbaceous, and scrub/shrub lands.
b/ Aquatic borrow areas.
c/ Bottom-land hardwoods and tree plantations.

IMPACT ANALYSIS

NET CHANGES IN THE EXTENT OF HABITAT

28. Under the "without-project" condition and implementation of the no-action and nonstructural alternatives, this habitat is expected to remain essentially the same as existing conditions for the economic life of the project.

29. The extent of habitat change if either Plans 3 or 4 were implemented without compensatory mitigation measures is presented in Table 14-4.

TABLE 14-4
NET EFFECTS TO BAT HABITAT AS A RESULT OF PLAN IMPLEMENTATION

Habitat Type	Plan 3	Plan 4
Memphis District		
Cleared Land a/	-3,607	-2,854
Open Water b/	0	+60
Woodlands c/	-3,078	-514
Vicksburg District		
Cleared Lands	-2,616	-7,423
Open Water	+11,800	+6650
Woodlands	-9,125	-5,416

TABLE 14-4 (Cont)

Habitat Type	Plan 3	Plan 4
	New Orleans District	
Cleared Lands	0	0
Open Water	+17	+17
Woodlands	-17	-17

NOTE: Minus denotes a loss of habitat acreage; and plus denotes a gain in habitat acreage.
a/ Agricultural, pasture lands, herbaceous lands, and scrub/shrub lands.
b/ Aquatic borrow areas.
c/ Bottom-land hardwoods and tree plantations.

Specific Impacts to Habitat by Species

30. Impacts of each alternative to habitat usage by species are depicted in Tables 14-5 through 14-7. Changes in land and water areas would affect different species with dissimilar life histories differentially. The loss of forest lands would reduce the potential number of trees that are hollow, those with loose bark, and those with dense foliage which provide roosting and feeding areas for most species in the project area. The loss of cleared areas would be expected to have potential adverse effects on those species that feed in cleared areas. Effects on the acreage of water in the project area would have beneficial effects on species that feed for insects over water.

TABLE 14-5
ROOSTING AND FEEDING HABITS FOR EVALUATION SPECIES

Species	Roosting and Feeding Habits
Little Brown Myotis	Roosts in attics, church steeples, hollow trees, or other sheltered spots. Feeding usually occurs close to the surface of a body of water.
Southeastern Myotis	Roosts in buildings and hollow trees. Forages for insects just above the surface of ponds and streams.
Northern Long-eared Myotis	Roosts in a variety of shelters, including buildings and under tree bark and shutters. Feeds in a variety of areas on flies.
Eastern Small-footed Bat	Cave inhabiting. Feeds near treetop level at the forest edge and often hunts along water course or ponds.
Eastern Pipistrelle	Most roost in trees, in hollow stumps, and on clusters of moss.
Big Brown Bat	Roosts in attics, under eaves of roofs, behind shutters or awnings, in chimneys, in church towers and occasionally in hollow trees, rock crevices, caves, or under the loose bark of dead trees. Prefers to forage among treetops.
Rafinesques Big-eared Bat	Roosts in barn lofts, attics, and old buildings. Feeds above ground.
Eastern Red Bat	Roosts in trees in Spanish moss or hang from twigs. Although it sometimes feeds over the tops of trees, it more often pursues insects in clearings.
Seminole Bat	Roosts in clumps of Spanish moss, occasionally found beneath loose bark or among clumps of foliage. Feeds on a variety of insects which it captures in and around the tree canopy.
Hoary Bat	Hangs from mostly evergreen branches. Feeds late at night high in the air.
Northern Yellow Bat	Roosts in the leaves of trees and in Spanish moss. Feeds over the Mississippi River itself or along the riverside of the mainline levees.
Silver-haired Bat	Roosts in hollow trees or clings behind the loose bark of trees or in clumps of leaves. Forages for insects in and among trees, most often near ponds or woodland streams.
Evening Bat	Roosts in hollow trees, in attics, abandoned houses, barns, and similar sites. Feeds above the trees at first then descends lower.
Brazialian Free-tailed Bat	Prefers the attics of old buildings, but is not averse to roosting in hollow trees. Feeds over open land.

TABLE 14-6
IMPACTS OF PLAN 3 TO BAT HABITAT

Species	Percent Decrease in Roosting Areas	Percent Decrease in Feeding Areas
Little Brown Bat	1.4	0.6
Southeastern Bat	1.4	0.7
Northern Long-eared Bat	1.4	0.0
Eastern Small-footed Bat	1.4	0.7
Eastern Pipistrelle	1.4	0.0
Big Brown Bat	1.4	1.4
Rafinesques Big-eared Bat	0.0	0.0
Eastern Red Bat	1.4	1.9
Seminole Bat	1.4	1.9
Hoary Bat	1.4	0.0
Northern Yellow Bat	1.4	0.0
Silver-haired Bat	1.4	1.4
Evening Bat	1.4	0.0
Brazialian Free-tailed Bat	1.4	0.0

TABLE 14-7
IMPACTS OF PLAN 4 TO SPECIES

Species	Percent Decrease in Roosting Areas	Percent Decrease in Feeding Areas
Little Brown Bat	0.6	0.0
Southeastern Bat	0.6	0.0
Northern Long-eared Bat	0.0	0.0
Eastern Small-footed Bat	0.0	0.15
Eastern Pipistrelle	0.6	0.0
Big Brown Bat	0.6	0.6
Rafinesques Big-eared Bat	0.0	0.0
Eastern Red Bat	0.6	0.5
Seminole Bat	0.6	0.4
Hoary Bat	0.6	0.0
Northern Yellow Bat	0.6	0.0
Silver-haired Bat	0.6	0.6
Evening Bat	0.6	0.15
Brazialian Free-tailed Bat	0.6	0.0

31. Data used to develop the preceding tables (Tables 14-3 through 14-7) reveal the type and magnitude of impacts to bat habitat would vary to a minor extent (from 0 to 1.9 percent) depending upon the alternative evaluated.

32. Each of the two structural plans, without compensation measures, would have similar impacts on bats and bat habitat. However, the magnitude of the impacts would vary by each plan. Each plan would result in very minor amounts of cleared lands being converted to other uses (0.4 to 1.9 percent). These lands would have provided some foraging habitat for the Eastern Red Bat, Rafinesques Big-eared Bat, and Brazialian Free-tailed bat. Open water (borrow areas) would be increased with each alternative, and this change would provide additional foraging areas for the Little Brown Myotis, Southeastern Myotis, Eastern Small-footed Bat, and Silver-haired Bat. Only very minor amounts of woodland would be converted to other uses with each alternative. These changes in woodland would reduce some roosting habitat for all evaluation species with the exception of the Rafinesques Big-eared Bat. The conversion of some woodlands would also result in a reduction in some foraging habitat for the Big Brown Bat and the Silver-haired Bat. Overall, adverse impacts without compensation measures to bats that could be present in the project area are assessed to be very minor, and beneficial effects to some species are assessed to be minor.

33. Plan 3 (the traditional plan) does not include any mitigation measures for significant terrestrial, wetlands, or waterfowl resources. Consequently, this plan would have more substantial adverse impacts to bat resources than Plan 4. Roosting habitat for all species would be reduced a minor amount with implementation of this alternative. Feeding areas for 7 species of the 14 species would also be reduced a minor amount.

34. Compensation measures of Plan 4 that will affect bats include converting some cleared lands in the project area to woodlands. Approximately 3,000 acres of borrow areas would be allowed to revert to woodlands and an additional 5,863 acres of cleared lands would be reforested in the project area. These measures would result in some of these areas becoming woodlands by the year 2013. By the year 2035, all areas reforested should be woodlands. At this time, there would be more woodlands in the project area than exist under existing conditions. These impacts would adversely affect species that feed over cleared areas; however, species that feed and roost in woodlands will benefit from these measures.

35. Species that would be adversely affected to a very minor degree by the compensation measures include the southeastern myotis, the eastern small-footed bat, and the eastern red bat. The remainder of the species discussed in this analysis would begin to experience improved habitat conditions to a very minor extent at least by the year 2035.

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APPENDIX 15
CULTURAL RESOURCES

Contract No. DACW38-96-D-0006
Delivery Order 002

U.S. Army Corps
of Engineers
Vicksburg District

REPORT FOR CULTURAL RESOURCES STUDY SUPPORTING SUPPLEMENT I TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT, MISSISSIPPI RIVER MAINLINE LEVEE, VICKSBURG AND MEMPHIS DISTRICTS

July 1998

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REPORT FOR CULTURAL RESOURCES STUDY SUPPORTING SUPPLEMENT I TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT, MISSISSIPPI RIVER MAINLINE LEVEE, VICKSBURG AND MEMPHIS DISTRICTS

Introduction

This document presents the initial results of the cultural resources study supporting Supplement I to the final Environmental Impact Statement. The literature and records review in progress on behalf of the Vicksburg and Memphis Districts includes 114 project areas in seven states including: 37 Louisiana items, 41 Mississippi segments, 19 Arkansas components, two areas in Tennessee, one item in Kentucky, nine Missouri elements [1/], and five sections in Illinois.

As specified in the Scope of Work, this literature and records review was designed to collect data pertaining to cultural resources identified within and adjacent to the 114 proposed project items. Research focused on previously conducted cultural resources inventories in the vicinity of the project area, archeological sites and cemeteries located within the study area, and recorded standing structures and National Register of Historic Places properties situated within the project corridor. A study corridor encompassing 2 km (1.2 mi) centered on each individual project item, in most cases artificial protection levees, was searched for evidence of cultural resources. When identified, historic properties were mapped on 7.5 minute USGS topographic quadrangles. Standing structure forms, National Register of Historic Places Nomination forms, and site forms for all cultural resources located within the project area were copied. No fieldwork was conducted during this current literature and records review.

This preliminary report presents basic data regarding previously identified cultural resources located directly within the project items only. Information regarding all previously recorded cultural resources positioned within the 2 km (1.2 mi) wide study corridor will be presented in the draft report. Data obtained during the current literature and records review is presented by U.S. Army Corps of Engineers District and then by state. A complete review of the project items located within the Vicksburg District is presented first, followed by a summary of the information collected for project items situated in the Memphis District. Within the section for each district, the data are presented by state, starting in the south and moving to the north.

Proposed SEIS Project Items Located Within the U.S. Army Corps of Engineers, Vicksburg District

The Vicksburg District portion of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS) includes project items within the states of Louisiana, Mississippi, and Arkansas (Tables 1 - 4). The proposed project items located within the Vicksburg District are presented below by state.

Louisiana

This section presents the preliminary results of a literature and records review for the Louisiana portion of the Vicksburg District segment of the U.S. Army Corps of Engineers Supplement to the Final Supplemental Environmental Impact Statement (SEIS). The information presented here is based on background information currently on file at the Louisiana Department of Culture, Recreation and Tourism, Office of Cultural Development, Division of Archaeology, Baton Rouge, Louisiana. The U.S. Army Corps of Engineers, Vicksburg District, portion of the SEIS includes 37 items in Louisiana.

1/ Note that information concerning one additional project item located within Missouri was not available and data collection is currently ongoing. In addition, two project items within Missouri were located parallel to one another and are reported on here as a single item.

Table 1. Cultural Resources Surveys within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

FIELD DATE	REPORT NUMBER	TITLE/AUTHOR	PROJECT DESCRIPTION	RESULTS AND RECOMMENDATIONS
LOUISIANA				
Not reported	22-132	Environmental Impact Statement Archaeological Survey of the Lake Bruin Sewerage Project, Tensas Parish Louisiana (Neitzel n.d.)	Records review, and pedestrian survey	Reidentified Site 24-L-4. The site was determined not to be impacted by the construction. No assessment of the significance or recommendations were reported.
1976	22-148	Archaeological Survey of the Louisiana Mississippi River Levee between Morville, Louisiana and Blackhawk, Louisiana (Servello n.d.)	Records review, pedestrian survey, and subsurface testing	Identified five historic sites (16CO52-16CO56). All were assessed as potentially significant; additional testing was recommended if the sites were to be impacted.
1977	22-17	Letter report. Subject: Cultural Resources Survey of Youngs Point Reid Bedford, Louisiana Levee. (Lewis 1977a)	Pedestrian survey	No cultural resources were identified; no additional testing was recommended.
ca. 1977	22-447	Letter report. Subject: Cultural Resources Survey of the Madison Parish Port Expansion. (Lewis 1977b)	Pedestrian survey	No cultural resources were identified; no additional testing was recommended.
ca. 1978	22-450	A Cultural Resource Survey of the Young's Point-Reid Bedford, Louisiana, Levee Between River Stations 3100 and 3375 (Price 1978)	Records review, pedestrian survey, and shovel testing	Identified Sites 16MA165-16MA174. Only Sites 16MA173 and 16MA174 were assessed as significant. Additional testing was recommended for Site 16MA173, but no recommendations were made for Site 16MA174 due to its location outside of the area of impact.
ca. 1980	22-679	A Cultural Resources Survey along the State Line to Wilson Point Levee Enlargement, East Carroll Parish, Louisiana (NLU 1980)	Records review, pedestrian survey and shovel testing	Identified 17 historic sites and 38 standing structure. One site (16EC63) and 4 structures (16EC68, 16EC73, 16EC74 & 16EC76) were assessed as significant. Recommended avoidance of two historic cemeteries (16EC64 & NLU-80-275) and additional testing.
1981	22-678	Cultural Resource Survey of Waterproof Berm, Tensas Parish, Louisiana (Yarbrough 1981)	Records review, pedestrian survey, and limited shovel testing	Three cultural resources loci were identified. No official state site numbers were reported for the loci. All of the loci were assessed as not significant. No additional testing was recommended.
ca. 1981	22-789	A Cultural Resources Survey of the Wilson Point to Point Lookout Levee Enlargement and Berm Project, East Carroll Parish, Louisiana (Heartfield, Price and Greene, Inc. 1981)	Records review, pedestrian survey, and shovel testing	Identified 33 sites, 2 isolated finds, 1 fence remnant, and 60 standing structures; reidentified Sites 16EC6 & 16EC17. Of these, only two sites (16EC6 & 16EC85) were assessed as potentially significant for which additional testing was recommended.

Table 1. Cultural Resources Surveys within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

FIELD DATE	REPORT NUMBER	TITLE/AUTHOR	PROJECT DESCRIPTION	RESULTS AND RECOMMENDATIONS
ca. 1995	22-1902	A Reevaluation of the Lake Providence Site (16EC6), East Carroll Parish, Louisiana (Thorne 1995)	Records review, pedestrian survey, unit excavation, shovel testing, and soil coring	Reevaluated the Lake Providence Site (16EC6). The site was assessed as eligible for the National Register. Additional testing was recommended.
MISSISSIPPI				
1979	79-042	Cultural Resource Survey of the Mississippi River Levee Enlargement and Berms, Valewood to Carlisle, Mississippi (Station 6475+00 to Station 7000+00) (Sisson 1979)	Records review and pedestrian survey	Identified two buried historic cemeteries and one previously recorded mound complex (22IS501). Site 22IS501 was assessed as potentially significant and avoidance of the site as well as the two cemeteries was recommended.
1980	No report number assigned	Cultural Resource Survey of the Caroline-Valewood, Mississippi, Levee Enlargement and Berms, Items 505-L, 502-L, and 500-L (Lewis 1980)	Records review, pedestrian survey and shovel testing	Identified five sites (22IS553 - 22IS557) and one historic standing structure. None were assessed as significant and no additional testing was recommended.
1981	No report number assigned	A Cultural Resources Survey from Carlisle to Tallula, MS, Levee Enlargement and Berms, Items 490-L, 486-L, and 481-L, Issaquena, MS (Johnson 1981)	Pedestrian survey and shovel testing	Identified a single historic period site (Site 1). No state site number was reported and the site was assessed as not significant. No additional testing was recommended.
1981	MS: No report number assigned; AR: 846	A Cultural Resources Survey of the Deerfield, Mississippi, Berm, Item B, Washington County, Mississippi, and Chicot County, Arkansas (Connaway and Brookes 1981)	Records review, pedestrian survey, shovel testing, probing, and borehole testing	Identified 12 historic sites (no state site numbers). Only the Griffin-Spragins House (151-GRU-5004) was nominated for the National Register of Historic Places. Avoidance of Site 2 was recommended.
1986	86-58	A Cultural Resources Survey of a Proposed Standing Gas Marketing Company Pipeline from an Existing ANR Natural Gas Pipeline in Section 36. T21N. R6W to the Mississippi River at Approximate River Mile 566, Bolivar County (HPG, Inc. 1986)	Records review, pedestrian survey, shovel testing, and bankline survey	Identified 17 cultural resources loci. All of the loci were assessed as not significant. No additional testing was recommended.
1993	94-434	Cultural Resource Inventory, Tullula-Magna Vista, Mississippi Berm Items 475-L-A and 475-L-B (Weisman et al. 1994)	Records review, pedestrian survey, and shovel testing	Identified 28 sites (22IS562 - 22IS589), 10 loci, and one previously recorded site (16IS520). Sites 22IS520 and 22IS581 were assessed as potentially significant and additional testing was recommended.

Table 1. Cultural Resources Surveys within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

FIELD DATE	REPORT NUMBER	TITLE/AUTHOR	PROJECT DESCRIPTION	RESULTS AND RECOMMENDATIONS
ARKANSAS				
1980	3189	A Cultural Resources Survey from Harwood Community to the Vicinity of Grand Lake Community, Chicot County, Arkansas (Binkley 1980)	Pedestrian survey	Identified two historic period artifact scatters, but no site numbers were assigned. The scatters were assessed as not significant and no additional testing was recommended.
1981	704	A Cultural Resources Survey of Levee Enlargement and Berm Areas, Lakeport to Harwood, Chicot County, Arkansas (Kelly 1981)	Records review and pedestrian survey	Identified 41 historic period sites (3CH90 - 3CH130). Four sites (3CH91, 3CH98, 3CH115, and 3CH121) were assessed as potentially significant, while Site 3CH90 was previously listed on the National Register.
1989	1496	A Cultural Resources Survey of the Proposed Texas Gas Transmission Corporation Gasline from Catfish Point, Desha County, Arkansas, to Glendale, Lincoln County, Arkansas (Mintz 1990)	Records review, pedestrian survey, and shovel testing	Identified six sites (3DE129 - 3DE132, 3LI108, and 3LI109). None were assessed as significant and no additional testing was recommended.

Table 2. Previously Recorded Sites within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

SITE NUMBER	USGS 7.5' QUADRANGLE	SITE DESCRIPTION	CULTURAL AFFILIATION	FIELD METHODOLOGY	NRHP ELIGIBILITY	RECORDED BY
LOUISIANA						
16EC6	Lake Providence	Five prehistoric mounds; historic period material scatter; prehistoric period material scatter	Possible Plaquemine and Coles Creek periods; late 19th century to present	Pedestrian survey, soil coring, unit excavation and shovel testing	Potentially Significant/ Nominated for National Register	Kniffen 1930s; Heartfield, Price and Greene, Inc. 1981; Perault 1997
16EC17	Transylvania	Prehistoric mound	Late Prehistoric-possibly Plaquemine period	Pedestrian survey, and soil probe	Potentially significant	LMS n.d.; Sanders 1995
16EC65	Millikin	Historic period material scatter	Undetermined historic	Pedestrian survey	Not significant	Hillman 1980
16EC78	Lake Providence	Historic period material scatter	Historic-possible 19th century	Pedestrian survey	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC84	Transylvania	Historic period material scatter	Undetermined historic	Pedestrian survey	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC98	Lake Providence	Historic period material scatter	Undetermined historic	Pedestrian survey, and shovel testing	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC99	Transylvania	Historic period material scatter	Undetermined historic	Pedestrian survey	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC100	Lake Providence	Historic period material scatter	Undetermined historic	Pedestrian survey, and shovel testing	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC104	Lake Providence	Historic period material scatter	20th century	Pedestrian survey	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC105	Lake Providence	Historic period material scatter	Undetermined historic	Pedestrian survey	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC106	Lake Providence	Historic period material scatter	Undetermined historic	Pedestrian survey	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC110	Lake Providence	Historic period standing structure	20th century (post 1930)	Pedestrian survey	Not significant	Heartfield, Price and Greene, Inc. 1981
		Historic period standing	20th century (post 1930)	Pedestrian survey	Not significant	Heartfield, Price and

Table 2. Previously Recorded Sites within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

SITE NUMBER	USGS 7.5' QUADRANGLE	SITE DESCRIPTION	CULTURAL AFFILIATION	FIELD METHODOLOGY	NRHP ELIGIBILITY	RECORDED BY
16EC111	Lake Providence	Historic period standing structure	20th century (post 1930)	Pedestrian survey	Not significant	Heartfield, Price and Greene, Inc. 1981
16EC117	Lake Providence	Historic period material scatter	Undetermined historic	Pedestrian survey, and shovel testing	Not significant	Heartfield, Price and Greene, Inc. 1981
MISSISSIPPI						
22IS501	Mayersville	Prehistoric mound complex; historic cemetery on one of the mounds	Prehistoric: Mayersville Phase and possibly Deer Creek Phase; Historic Cemetery: Mid-19th century period-modern period	Pedestrian survey	Listed on National Register (1980)	Phillips 1950
22IS555	Mayersville	Historic period materials scatter	Undetermined historic	Pedestrian survey, and shovel testing	Not significant	Lewis 1980
22IS562	Fitler	Historic period materials scatter	Late 19th - early 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS563	Fitler	Historic period materials scatter	Late 19th - 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS564	Fitler	Historic period materials scatter	Late 19th - 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS570	Fitler	Historic period materials scatter	20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS574	Fitler	Historic period materials scatter and structural features	Late 19th - early 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS575	Fitler	Historic period materials scatter	Late 19th - 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS576	Fitler	Historic period materials scatter	Late 19th - 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS577	Fitler	Historic period materials scatter	Late 19th - 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993

Table 2. Previously Recorded Sites within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

SITE NUMBER	USGS 7.5' QUADRANGLE	SITE DESCRIPTION	CULTURAL AFFILIATION	FIELD METHODOLOGY	NRHP ELIGIBILITY	RECORDED BY
22IS578	Whiting Bayou	Historic period materials scatter	Late 19th - early 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS580	Whiting Bayou	Historic period materials scatter	19th - mid 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS581	Whiting Bayou	Lockwood Plantation: Historic period materials scatter, structural features and possible slave cemetery	Early 19th - late 20th century historic period	Pedestrian survey and shovel testing	Potentially significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS582	Whiting Bayou	Historic period materials scatter	19th - 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS583	Whiting Bayou	Historic period materials scatter	Late 19th - mid-20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
22IS588	Fitler	Historic period materials scatter	Late 19th - early 20th century historic period	Pedestrian survey and shovel testing	Not significant	R. Christopher Goodwin & Assoc., Inc. 1993
ARKANSAS						
3CH90 (Standing Structure # CH0007)	Red Leaf	Lakeport Plantation: standing structures and historic period material scatter	19th and 20th century historic period	Pedestrian survey and shovel testing	Listed in 1974	Kelly 1981; Stewart-Abernathy 1984
3CH91	Red Leaf	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Potentially significant	Lane 1981
3CH92	Red Leaf	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH93	Red Leaf	One standing structure	20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH94	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH95	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH97	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH98	Eminence	Two standing structures	20th century historic period	Pedestrian survey	Potentially significant	Lane 1981

Table 2. Previously Recorded Sites within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

SITE NUMBER	USGS 7.5' QUADRANGLE	SITE DESCRIPTION	CULTURAL AFFILIATION	FIELD METHODOLOGY	NRHP ELIGIBILITY	RECORDED BY
~~3CH99~~	~~Eminence~~	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH102	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH104	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH105	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH106	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH107	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH109	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH110	Eminence	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH114	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH115	Avon	Five standing structures	20th century historic period	Pedestrian survey	Potentially significant	Lane 1981
3CH117	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH118	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH119	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH120	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH121	Eminence	Historic period materials scatter; five standing structures; three cisterns	19th and 20th century historic period	Pedestrian survey	Potentially significant	Lane 1981
3CH122	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH123	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not assessed	Lane 1981
3CH124	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not assessed	Lane 1981
3CH125	Avon	Historic period materials scatter	19th and 20th century historic period	Pedestrian survey	Not significant	Lane 1981

Table 2. Previously Recorded Sites within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

SITE NUMBER	USGS 7.5' QUADRANGLE	SITE DESCRIPTION	CULTURAL AFFILIATION	FIELD METHODOLOGY	NRHP ELIGIBILITY	RECORDED BY
~~3CH126~~	~~Avon~~	Historic period materials scatter	20th century historic period	Pedestrian survey	Not significant	Lane 1981
3CH127	Avon	Four standing structures	20th century historic period	Pedestrian survey	Not significant	Lane 1981
3DE129	Catfish Point	Historic period materials scatter	Undetermined historic period	Pedestrian survey and shovel testing	Not significant	Mintz 1989

Table 3. Standing Structures within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

STANDING STRUCTURE NO.	ADDRESS	TYPE	DATE RANGE
MISSISSIPPI			
151-LKW-7004-X	Vicinity of Chatham, MS	Not reported	Not reported
ARKANSAS			
CH0010	Vicinity of Luna, AR	Columbia Community location	ca. 1840
CH0154	Lake Port, AR	Lake Port House	ca. 1915
DE0087	Vicinity of Cypress Bayou and Boggy Bayou, AR	Cypress Bend Battle location	1863

Table 4. Cemeteries within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Vicksburg District.

CEMETERY NAME	ADDRESS	TYPE	DATE RANGE
LOUISIANA			
Mt. Pleasant Church Cemetery	Millikin, LA	Unknown	Unknown
MISSISSIPPI			
Filter Cemetery (Site 22IS573)	Vicinity of Filter, MS	Bulldozed historic cemetery	Late 19th-20th century
Mayfield Cemetery (Site 22IS579)	Vicinity of Filter, MS	Small historic cemetery	ca. 1812-1973
St. James Church Cemetery	State Highway 1, Vicinity of Tallula, MS	Unknown	Unknown
Unnamed Cemetery (NLU-86-129)	Vicinity of Eutaw, MS	Historic	Late 19th century
Unnamed Cemetery (NLU-86-130)	Vicinity of Eutaw, MS	Historic	Unknown

Vidalia-Moreville, La., Levee and Berm, Item #357.0-R

A portion of the currently proposed project area may have been subject to a cultural resources survey by A. Frank Servello in 1976 (Servello n.d.); however, no map showing the area subjected to cultural resources survey was provided in the report. Pedestrian survey augmented by subsurface testing of the Mississippi River Levee between Moreville, Louisiana and Blackhawk, Louisiana identified five historic sites (16CO52 - 16CO56). Servello assessed all five sites as potentially significant and recommended additional testing. None of these sites are located within the proposed project area.

Vidalia-Moreville, La., Levee and Berm, Item #361.0-R

No cultural resources surveys or previously identified sites were located within the proposed Item #361.0-R project area. In addition, an examination of the historic architecture files failed to identify any standing structures or cemeteries within the proposed Item #361.0-R project area.

Vidalia-Moreville, La., Levee and Berm, Item #365.0-R

No cultural resources inventories or previously recorded archeological sites were located within the proposed Item #365.0-R project area. Additionally, examination of the historic architecture files failed to identify any standing structures or cemeteries within the proposed Item #365.0-R project area.

Upper Lake Concordia-Vidalia, La., Levee and Berm, Item #366.0-R

No cultural resources surveys or previously recorded sites were identified within the proposed Item #366.0-R project area. Moreover, an examination of the historic architecture files failed to locate any cemeteries or built resources within the proposed Item #366.0-R project area.

Upper Lake Concordia-Vidalia, La., Levee and Berm, Item #367.0-R

No cultural resources surveys or recorded archeological sites were located within the proposed Item #367.0-R project area. In addition, an examination of the historic architecture files failed to identify any standing structures or cemeteries within the proposed Item #367.0-R project area.

Waterproof-Upper Lake Concordia, La., Levee and Berm, Item #368.0-R

No cultural resources inventories or previously recorded sites or cemeteries were identified within the proposed Item #368.0-R project area. Moreover, an examination of the historic architecture files failed to locate any standing structures within the proposed Item #368.0-R project area.

Waterproof-Upper Lake Concordia, La., Levee and Berm, Item #370.0-R

No cultural resources surveys or previous investigations were identified within the proposed Item #370.0-R project area. In addition, an examination of the historic architecture files failed to identify any standing structures with the proposed Item #370.0-R project area.

Waterproof-Upper Lake Concordia, La., Levee and Berm, Item #374.0-R

No cultural resources inventories or previously recorded sites or cemeteries were identified within the proposed Item #374.0-R project area. Moreover, an examination of the historic architecture files failed to locate any standing structures within the proposed Item #374.0-R project area.

Waterproof-Upper Lake Concordia, La., Levee and Berm, Item #377.0-R

No cultural resources inventories or previously recorded sites were located within the proposed Item #377.0-R project area. Additionally, an examination of the historic architecture files failed to locate any built resources or cemeteries within the proposed Item #377.0-R project area.

St. Joseph-Waterproof, La., Levee and Berm, Item #380.0-R

No cultural resources surveys or previously recorded archeological sites or cemeteries were identified within the proposed Item #380.0-R project area. Additionally, an examination of the historic architecture files failed to identify any standing structures within the proposed Item #380.0-R project area.

St Joseph-Waterproof, La., Levee and Berm, Item #385.0-R

During January, 1981, a 3.2 km (2.0 mi) long portion of the currently proposed 8.0 km (5.0 mi) long project area was subject to cultural resources survey by the Environmental Analysis Branch, Planning Division, Vicksburg District, U.S. Army Corps of Engineers (Yarbrough 1981). The proposed Waterproof Berm project area, located in Tensas Parish, was defined as the area between Levee Stations 6550 and 6440. The project area extended 198.1 m (650 ft) from the levee centerline on the landside and 198.1 m (600 ft) [southern reaches] to 609.6 m (2000 ft) [northern reaches] from the levee centerline on the riverside. Archeological testing of the project area, consisting of pedestrian survey and shovel testing, identified three cultural resources loci (Sites 1 - 3). No official state site numbers were reported for the loci. Yarbrough assessed the loci as not significant and no additional testing was recommended (1981).

St. Joseph-Waterproof, La., Levee and Berm, Item #388.0-R

No cultural resources inventories or previously recorded archeological sites were identified within the proposed Item #388.0-R project area. Moreover, an examination of the historic architecture files failed to identify any cemeteries or built resources within the proposed Item #388.0-R project area.

St. Joseph-Waterproof, La., Levee and Berm, Item #393.0-R

On an unspecified date, a small portion of the proposed Item #393.0-R project area was subjected to a cultural resources survey by Robert S. Neitzel at the request of Meyer, Meyer, La Croix & Hixson, Inc. (Neitzel n.d.). The project area comprised approximately 64.7 km^2 (25 mi^2) surrounding and including Lake Bruin. Pedestrian survey reidentified Site 24-L-4, which was determined to be outside of the area of proposed impact. No assessment of the significance of the site or recommendations for additional testing were reported. Site 24-L-4 is located outside of the proposed Item #393.0-R project area.

Yucatan-Lake Bruin, La., Levee and Berm, Item #398.0-R

As was previously discussed, a large portion of the proposed Item #398.0-R project area was subject to a cultural resources survey by Robert S. Neitzel at the request of Meyer, Meyer, La Croix & Hixson, Inc. on an unspecified date (Neitzel n.d.). The results of this survey are summarized above. No cultural resources were identified within the proposed Item #398.0-R project area.

Yucatan-Lake Bruin, La., Levee and Berm, Item #401.0-R

On an unspecified date, a small portion of the proposed Item #401.0-R project area was subject to a cultural resources survey by Neitzel at the request of Meyer, Meyer, La Croix & Hixson, Inc., as previously mentioned (Neitzel n.d.). This survey is discussed above; no cultural resources were identified within the Item #401.0-R proposed project area.

Point Pleasant-Yucatan, La., Levee and Berm, Item #407.0-R

No cultural resources surveys or previously recorded sites or cemeteries were identified within the proposed Item #407.0-R project area. In addition, an examination of the historic architecture files failed to identify any standing structures within the proposed Item #407.0-R project area.

Point Pleasant-Yucatan, La., Levee and Berm, Item #409.0-R

No cultural resources inventories or previously documented archeological sites or cemeteries were identified within the proposed Item #409.0-R project area. Additionally, examination of the historic architecture files failed to locate any built resources within the proposed Item #409.0-R project area.

Point Pleasant-Yucatan, La., Levee and Berm, Item #411.0-R

No cultural resources surveys or previously recorded sites were identified within the proposed Item #411.0-R project area. Moreover, an examination of the historic architecture files failed to locate any cemeteries or built resources within the proposed Item #411.0-R project area.

Bayou Vidal-Elkridge, La., Levee and Berm, Item #414.0-R

No cultural resources inventories or previously located archeological sites or cemeteries were identified within the proposed Item #414.0-R project area. In addition, an examination of the historic architecture files failed to identify any standing structures within the proposed Item #414.0-R project area.

Bayou Vidal-Elkridge, La., Levee and Berm, Item #416.0-R

No cultural resources inventories or previously recorded sites were identified within the proposed Item #416.0-R project area. Additionally, examination of the historic architecture files failed to locate any standing structures or cemeteries within the proposed Item #416.0-R project area.

Bayou Vidal-Elkridge, La., Levee and Berm, Item #419.0-R

No cultural resources surveys or previously recorded archeological sites or cemeteries were identified within the proposed Item #419.0-R project area. Moreover, an examination of the historic architecture files failed to identify any built structures within the proposed Item #419.0-R project area.

Bayou Vidal-Elkridge, La., Levee and Berm, Item #421.0-R

No cultural resources inventories or previously located sites were identified within the proposed Item #421.0-R project area. Additionally, an examination of the historic architecture files failed to identify any standing structures or cemeteries within the proposed Item #421.0-R project area.

Reid Bedford-King, La., Levee and Berm, Item #422.0-R

No cultural resources surveys or previously documented archeological sites were identified within the proposed Item #422.0-R project area. In addition, an examination of the historic architecture files failed to locate any cemeteries or standing structures within the proposed Item #422.0-R project area.

Reid Bedford-King, La., Levee and Berm, Item #424.0-R

No cultural resources surveys or previously documented sites or cemeteries were identified within the proposed Item #424.0-R project area. In addition, an examination of the historic architecture files failed to identify any built resources within the proposed Item #424.0-R project area.

Reid Bedford-King, La., Levee and Berm, Item #428.0-R

An approximately 0.1 km (0.06 mi) long portion of the currently proposed 4.6 km (2.9 mi) long project area was subjected to a cultural resources survey in 1977 by the U.S. Army Corps of Engineers, Vicksburg District (Lewis 1977a). According to Lewis, the proposed right-of-way extended approximately 304.8 m - 609.6 m (1,000 ft - 2,000 ft) riverside from the existing levee centerline. Pedestrian survey failed to identify any cultural resources; no additional testing was recommended based on the disturbance and recent alluvial deposition of the soil (Lewis 1977a).

Proposed Willow Point-Youngs Point, La., Levee and Berm , Item #445.0-R

A small portion of the currently proposed project area may have been subject to cultural resources survey prior to June, 1978 by Heartfield, Price and Greene, Inc. at the request of the U.S. Army Corps of Engineers, Vicksburg District (Price 1978). Price reported that the project area was located between river stations 3100 and 3575 (1978). Pedestrian survey augmented by shovel testing identified 10 sites (16MA165 -16MA174). Sites 16MA173 and Site 16MA174 were assessed as significant. Additional testing was recommended for Site 16MA173, but no recommendations were made for 16MA174 due to its location outside the area of impact. All of these sites are located outside of the proposed project area.

Willow Point-Youngs Point, La., Levee and Berm, Item #450.0-R

No cultural resources inventories or previously documented archeological sites or cemeteries were identified within the proposed Item #450.0-R project area. Moreover, an examination of the historic architecture files failed to locate any standing structures within the proposed Item #450.0-R project area.

Willow Point-Youngs Point, La., Levee and Berm, Item #453.0-R

No cultural resources surveys or previously recorded sites were located within the proposed Item #450.0-R project area. In addition, examination of the historic architecture files failed to identify any cemeteries or built resources within the proposed Item #453.0-R project area.

Willow Point-Youngs Point, La., Levee and Berm, Item #457.0-R

A portion of the currently proposed Item #457.0-R project area was subject to a cultural resources survey in August, 1977 by the U.S. Army Corps of Engineers, Vicksburg District (Lewis 1977b). The inventory of the proposed expansion of the Madison Parish Port consisted of a pedestrian survey. No cultural resources were identified and no additional testing was recommended.

Wilson Point-Point Lookout, La., Levee and Berm, Item #461.0-R

No cultural resources inventories or previously recorded archeological sites were identified within the proposed Item #461.0-R project area. In addition, an examination of the historic architecture files failed to identify any standing structures or cemeteries within the proposed Item #461.0-R project area.

Wilson Point-Point Lookout, La., Levee and Berm, Item #480.0-R

Prior to April, 1981, Heartfield, Price, and Greene, Inc. completed a cultural resources survey of the Wilson Point to Point Lookout Levee Enlargement and Berms Project at the request of the U. S. Army Corps of Engineers, Vicksburg District (Heartfield, Price and Greene, Inc. 1981). The entire currently proposed Item #480.0-R project area was included in this survey. Pedestrian survey augmented by shovel testing identified

33 archeological sites (16EC78, 16EC84 - 16EC108, 16EC117, 16EC118, NLU-81-3, NLU-81-70, NLU-81-73, and NLU-81-85), two isolated finds (X16EC-B and X16EC-C), 60 standing structures, one fence remnant (NLU-81-55), and reidentified Sites 16EC6 and 16EC17. Of these sites, only sites 16EC6 and 16EC85 were assessed as potentially significant. Site 16EC99 is the only resource located within the proposed Item #480.0-R project area.

Site 16EC99 was characterized as a light scatter of materials of an undetermined historic cultural affiliation. The site was assessed as not significant by Heartfield, Price and Greene, Inc (1981) and no additional testing was recommended.

Wilson Point-Point Lookout, La., Levee and Berm, Item #483.0-R

Prior to April, 1981, Heartfield, Price, and Greene, Inc. completed a cultural resources survey of the Wilson Point to Point Lookout Levee Enlargement and Berms Project at the request of the U. S. Army Corps of Engineers, Vicksburg District (Heartfield, Price and Greene, Inc. 1981). The results of the inventory are presented above. The entire currently proposed project area was included in the Heartfield, Price, and Greene (1981) survey area. A total of two sites, 16EC17 and 16EC84, identified by Heartfield, Price, and Greene are located within the proposed Item #483.0-R project area.

According to the State of Louisiana State Record Form, Site 16EC17 originally was recorded by an unspecified party in the 1960s and updated by Joe Saunders in 1995. The site was described as an eroded prehistoric mound. Based on the lack of soil development, Saunders suggested that the mound dated from the Plaquemine period. Field methodology utilized by Saunders consisted of pedestrian survey and soil probing. A variety of prehistoric artifacts were observed, including grog-tempered ceramic sherds, debitage, a modified flake and a possible core. Although Heartfield, Price and Greene, Inc. (1981) assessed Site 16EC17 as not significant because they believed that the mound was of historic origin, Saunders has since suggested that the site is prehistoric and eligible for listing in the National Register of Historic Places. Saunders recommended that the mound be tested before the top half of the mound has eroded away.

Site 16EC84 was described as very sparse historic scatter probably dating from the 1930s. Fieldwork undertaken by Heartfield, Price and Greene consisted of a pedestrian survey that resulted in the recovery of one glass shard, one whiteware sherd, and one stoneware sherd. The site was assessed as not significant and no additional testing was recommended.

Wilson Point-Point Lookout, La., Levee and Berm, Item #485.0-R

As was discussed previously, Heartfield, Price, and Greene, Inc. completed a cultural resources survey prior to April, 1981 of the Wilson Point to Point Lookout Levee Enlargement and Berms Project at the request of the U. S. Army Corps of Engineers, Vicksburg District (Heartfield, Price and Greene , Inc. 1981). The results of this inventory are presented above. The entire currently proposed Item #485.0-R project area was included in this survey. Sites 16EC98, 16EC100 and 16EC117, all recorded by Heartfield, Price and Greene, are located on the levee within the proposed Item #485.0-R project area.

Sites 16EC98, 16EC100 and 16EC117 were described as sparse historic scatters dating from an undetermined historic cultural period. Fieldwork at these sites consisted of pedestrian survey and shovel testing. All of the sites were assessed as not significant and no additional testing was recommended (Heartfield, Price and Greene, Inc. 1981).

Wilson Point-Point Lookout, La., Levee and Berm, Item #487.0-R

As was discussed above, Heartfield, Price, and Greene, Inc. completed a cultural resources survey prior to April, 1981 of the Wilson Point to Point Lookout Levee Enlargement and Berms Project at the request of the U. S. Army Corps of Engineers, Vicksburg District (Heartfield, Price and Greene , Inc. 1981). The

results of this inventory are presented above. The entire currently proposed project area was included in this survey. None of the sites identified by Heartfield, Price and Greene are located within the proposed Item #487.0-R project area.

Wilson Point - Point Lookout, La., Levee and Berm, Item #489.0-R

As discussed above, Heartfield, Price, and Greene, Inc. completed a cultural resources survey prior to April, 1981 of the Wilson Point to Point Lookout Levee Enlargement and Berms Project at the request of the U. S. Army Corps of Engineers, Vicksburg District (Heartfield, Price and Greene, Inc. 1981). The results of this survey are described above. The entire currently proposed Item #489.0-R project area was included in this survey. Of the many cultural resources listed by Heartfield, Price and Greene, sites 16EC6, 16EC78, 16EC104, 16EC105, 16EC106, 16EC110 and 16EC111 are located within the proposed Item #489.0-R project area.

According to the State of Louisiana Site Record Form, Site 16EC6 was recorded first by Kniffin in the 1930s and has been investigated numerous times since then (Heartfield, Price and Greene, Inc. 1981; Thorne 1995). Heartfield, Price, and Greene, Inc. (1981) reported that Site 16EC6 represented prehistoric mounds and village dating from post 1000 A.D. Site 16EC6 was assessed as potentially significant by Heartfield, Price and Greene, Inc. (1981); additional testing to determine if *in situ* cultural deposits were present at the site was recommended. In addition, Tony Dieste of Heartfield, Price and Green, Inc., completed a National Register of Historic Places Inventory Nomination Form in 1981 for Site 16EC6; however, the site is not currently listed on the National Register.

Prior to May 1995, Robert Thorne reelavuated Site 16EC6 at the request of the U. S. Army Corps of Engineers, Environmental Analysis Branch, Vicksburg District (Thorne 1995). Fieldwork conducted at that time consisted of pedestrian survey, soil coring, shovel testing and unit excavation. Thorne agreed with the assessment offered by Heartfield, Price and Greene, Inc. (1981) and he recommended additional testing.

Stephanie Perrault of Coastal Environments, Inc. submitted a State of Louisiana Site Record Update Form during February, 1997 detailing additional testing of Site 16EC6. According to the information provided on the Site Update Form, the site was described as consisting of five mounds, two intact middens, and a surface scatter of both prehistoric and historic period cultural materials. Pedestrian survey, soil coring, and unit excavation resulted in the collection prehistoric ceramic sherds, historic ceramic sherds, glass shards, nails, and bricks. It was suggested that Site 16EC6 represented a possible Plaquemine and Coles Creek period cultural affiliation as well as a late nineteenth - late twentieth century historic period of occupation. Perrault stated that Site 16EC6 had been nominated to the National Register of Historic Places and recommend data recovery in order to mitigate future levee berm and road construction impacts. A cultural resources survey report detailing this information has not yet been received by the Louisiana Department of Culture, Recreation, and Tourism, Office of Cultural Development, Division of Archaeology (Mike Mahady 1997; personal communication).

Site 16EC78 was characterized as a sparse historic scatter that may have been associated with the nineteenth century All Right Plantation (Heartfield, Price and Greene, Inc. 1981). Fieldwork conducted at this site consisted of a pedestrian survey. The site was assessed as not significant and no additional testing was recommended.

Site 16EC104 was described as a sparse historic materials scatter dating from the twentieth century (Heartfield, Price and Greene, Inc. 1981). Only small brick fragments were observed during the pedestrian survey. The site was assessed as not significant and no additional testing was recommended.

Both Site 16EC105 and Site 16EC106 were described as sparse historic material scatters of undetermined cultural affiliation. (Heartfield, Price and Greene, Inc. 1981). Fieldwork at these locales consisted of pedestrian survey. The sites were as assessed as not significant and no additional testing was recommended.

Sites 16EC110 and 16EC111 were characterized as "L" shaped wooden structures dating post 1930 (Heartfield, Price and Greene, Inc. 1981). The structures functions were reported as unknown. Both structures were assessed as not significant and no additional testing was recommended.

State Line-Wilson Point, La., Levee and Berm, Item #503.0-R

Prior to August, 1980, The Research Institute, College of Pure and Applied Sciences, Northeast Louisiana University conducted a cultural resources survey of the State Line to Wilson Point Levee Enlargement in East Carroll Parish, Louisiana (NLU 1980). Requested by the U.S. Army Corps of Engineers, Vicksburg District, the survey was conducted between the Arkansas - Louisiana state line and the point 32°09'38" longitude and 91°09'38" latitude. The width of the survey corridor was reported as 914.4 m (3000 ft) riverward of the centerline of the existing levee or 70 m (200 ft) riverward of Grassaway Lake. The entire currently proposed Item #503.0-R project area was included in the NLU (1980) survey. Archeological testing, consisting of pedestrian survey augmented by shovel testing, identified 17 historic sites (16EC55 - 16EC65; NLU-80-211, -215, -217, -219, -265, and -275) and 38 standing structures (16EC66 - 16EC77; NLU-80-222, -224 to -226, -228 to -235, -237, -239 to -241, -243, -244, -246, -247, -250, -251, -254, -255, -258 and -267). Site 16EC63 and standing structures 16EC68, 16EC73, 16EC74 and 16EC76 were assessed as potentially significant. Additional testing of Site 16EC63 was recommended along with additional evaluation of standing structures 16EC68, 16EC73, 16EC74, and 16EC76. In addition, avoidance of the two historic cemeteries (Sites 16EC64 and NLU-80-275) identified during cultural resources inventory also was recommended. Only site 16EC65 was located within the proposed Item 503.0-R project area.

Site 16EC65 was described as a low density historic artifact scatter of undetermined cultural affiliation (NLU 1980). Fieldwork consisted of a pedestrian survey. The site was assessed as not significant. Although no additional testing or research was advised in the submitted report, a recommendation for additional documentary research was reported on the State of Louisiana Site Form.

State Line-Wilson Point, La., Levee and Berm, Item #506.0-R

As previously discussed, The Research Institute, College of Pure and Applied Sciences, Northeast Louisiana University conducted a cultural resources survey prior to August, 1980 of the State Line to Wilson Point Levee Enlargement in East Carroll Parish, Louisiana on behalf of the U.S. Army Corps of Engineers, Vicksburg District (NLU 1980). The results of this inventory are presented above. The entire currently proposed Item #506.0-R project area was included in the NLU (1980) survey. No cultural resources were located within the Item 506.0-R project area.

Although no previously reported archeological sites or standing structures are located within the project area, Mt. Pleasant Church Cemetery is located partially within the Item 506.0-R project area. The cemetery is situated beside the Mt. Pleasant Church in Millikin, Louisiana. Mt. Pleasant Church Cemetery is not registered in the state archeological files or state historic preservation files. The only information gathered on this cemetery is its location; this information was obtained from the Millikin, LA-MS, USGS 7.5' series quad map.

Mississippi

Data supplied here are based on a background search of information currently on file at the Mississippi Department of Archives and History, Division of Historic Preservation, Jackson, Mississippi. The U.S. Army Corps of Engineers, Vicksburg District, portion of the SEIS includes 38 items located in Mississippi.

<u>Brunswick-Halpino, Ms., Levee and Berm, Item #452.0-L</u>

No cultural resources inventories or previously recorded sites were identified within the proposed Item #452.0-L project area. In addition, an examination of the standing structure files failed to identify any standing structures or cemeteries within the proposed Item #452.0-L project area.

<u>Brunswick-Halpino, Ms., Levee and Berm, Item #458.0-L</u>

No cultural resources surveys or previously recorded sites were identified within the proposed Item #458.0-L project area. Additionally, examination of the standing structure files failed to identify any built resources or cemeteries within the proposed Item #458.0-L project area.

<u>Brunswick-Halpino, Ms., Levee and Berm, Item #460.0-L</u>

No cultural resources inventories or previously recorded sites were identified within the proposed Item #460.0-L project area. In addition, examination of the standing structure files failed to identify any standing structures or cemeteries within the proposed Item #460.0-L project area.

<u>Magna Vista-Brunswick, Ms., Levee and Berm, Item #462.0-L</u>

No cultural resources inventories or previously recorded sites were identified within the proposed Item #462.0-L project area. Moreover, an examination of the standing structure files failed to identify built resources or cemeteries within the proposed Item #462.0-L project area.

<u>Magna Vista-Brunswick, Ms., Levee and Berm, Item #463.0-L</u>

No cultural resources surveys or previously recorded archeological sites or cemeteries were identified within the proposed Item #463.0-L project area. Additionally, examination of the standing structure files failed to identify any standing structures within the proposed Item #463.0-L project area.

<u>Magna Vista-Brunswick, Ms., Levee and Berm, Item #465.0-L</u>

No cultural resources inventories or previously recorded sites were identified within the proposed Item #465.0-L project area. In addition, an examination of the standing structures files failed to identify any built resources or cemeteries within the proposed Item #465.0-L project area.

<u>Magna Vista-Brunswick, Ms., Levee and Berm, Item #467.0-L</u>

During September and December, 1993, an approximately 0.3 km (0.2 mi) long portion of the currently proposed 4.9 km (3.0 mi) long project area was the subject of Phase I cultural resources inventory by R. Christopher Goodwin & Associates, Inc., at the request of the U.S. Army Corps of Engineers, Vicksburg District (Weisman et al. 1994). According to Weisman et al. (1994), the survey area encompassed 2,820 ac (1,141 ha) between Levee Stations 7430+00 and 7990+00. Pedestrian survey augmented by shovel testing resulted in the identification of 28 sites (22IS562 - 22IS589) and 10 historic cultural resources loci (TMV 2-2, TMV 3-6, TMV 5-2, TMV 10-1, TMV 10-3, TMV 11-2, TMV 11-3, TMV 13-2, TMV 13-3, and TMV 18-5), and the investigation of one previously recorded site (22IS520). Of these sites and loci, only sites 22IS520 and 22IS581 were assessed as potentially significant; additional testing or avoidance of these two sites was

recommended. Additionally, avoidance of Site 22IS573 (Filter Cemetery), Site 22IS579 (Mayfield Cemetery), and Site 22IS589 (Shiloh Cemetery) was recommended. None of these resources are located within the proposed Item #467.0-L project area.

Tallula-Magna Vista, Ms., Levee and Berm, Item #471.0-L

R. Christopher Goodwin & Associates, Inc., conducted a Phase I cultural resources inventory, between September and December 1993, of the entire 3.5 km (2.2 mi) length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Weisman et al. 1994). The results of this survey are presented above. Only one site, 22IS570, identified by R. Christopher Goodwin & Associates, Inc. was located within the proposed Item #471.0-L project area.

Site 22IS570 was characterized as dense scatter of historic artifacts dating from the late nineteenth century. Site 22IS570 was assessed as not significant; no additional testing was recommended.

Tallula-Magna Vista, Ms., Levee and Berm, Item #474.0-L

R. Christopher Goodwin & Associates, Inc. conducted Phase I cultural resources survey of the entire 3.9 km (2.4 mi) length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Weisman et al. 1994). The results of this survey are presented above. While many cultural resources were identified by R. Christopher Goodwin & Associates, Inc., only Sites 22IS562, 22IS563 and 22IS564 were located within the proposed Item #474.0-L project area.

Sites 22IS562, 22IS563, and 22IS564 were all characterized as low density historic artifact scatters dating from the late nineteenth century to the early twentieth century. Sites 22IS562, 22IS563, and 22IS564 were assessed as not significant; no additional testing of these three sites was recommended.

Tallula-Magna Vista, Ms., Levee and Berm, Item #476.0-L

During July, 1981, the entire 8.4 km (5.2 mi) length of the currently proposed project area was subject to Phase I cultural resources survey by the Center for Archaeological Research at the University of Mississippi at the request of the U.S. Army Corps of Engineers, Vicksburg District (Johnson 1981). The survey area encompassed a 1,400 m (4,600 ft) wide survey corridor. This corridor extended 183 m (600 ft) to the landward side and 1,219 m (4000 ft) of the riverside of the levee centerline from Carlisle to Tallula, Mississippi, and was referred to as project Items 490-L, 486-L, and 481-L. Pedestrian survey augmented by shovel testing identified one historic period site (Site 1). No official state site number was reported. Site 1 was located outside the currently proposed project area. The site was assessed as not significant and no additional testing was recommended.

R. Christopher Goodwin & Associates, Inc. also conducted a Phase I cultural resources survey of the entire 8.4 km (5.2 mi) length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Weisman et al. 1994). The results of this investigation are described above. Of the cultural resources identified by R. Christopher Goodwin & Associates, Inc., only sites 22IS573 - 22IS583, 22IS588 are located within the proposed Item #476.0-L project area.

Site 22IS573 was characterized as a light scatter of late nineteenth to twentieth century historic cultural material surrounding the historic Filter Cemetery (Weisman et al. 1994). During the late 1950s or the early 1960s, the cemetery reportedly was bulldozed, displacing most of the grave markers. According to Weisman et al. (1994), an informant stated that the cemetery contained between 150 and 250 graves. Avoidance of Site 22IS573 during proposed construction was recommended.

Site 22IS574 was described as a light historic period materials scatter, structure foundation, and chimney dating from the late nineteenth century - early twentieth century (Weisman et al 1994). The site was assessed as not significant; no additional testing was recommended.

Sites 22IS575 - 22IS578, 22IS580, 22IS582, 22IS583, and 22IS588 were characterized as light historic period artifact scatters dating from the late nineteenth century - early twentieth century (Weisman et al. 1994). All of these sites were assessed as not significant and no additional testing was recommended.

Site 22IS579 was described as the Mayfield Cemetery. In addition to the cemetery itself, the site consisted of a light historic period artifact scatter. It was reported that the cemetery included three or four historic graves (Weisman et al. 1994). Headstones ranged in date from 1812 to 1973. According to Weisman et al. (1994), at least ten structures that once stood on the property were moved, demolished or burned prior to the time of survey. Although no intact cultural deposits were identified at Site 22IS579, Weisman et al. (1994) speculated that privy and cistern features may be present at the site. Avoidance of Site 22IS579 was recommended; however, the site was assessed as not eligible for the National Register of Historic Places.

Site 22IS581 (Lockwood Plantation) consisted of the foundations of a two story plantation house, a segment of a nineteenth century levee, a portion of the old river road, a possible slave cemetery, and a historic period artifact scatter that may be associated with slave and later share cropper dwellings (Weisman et al. 1994). It was reported that the plantation house was constructed in 1833 and destroyed by a tornado in 1973. On the east side of the plantation house were the remains of two stores that supplied local share croppers. Site 22IS581 was assessed as potentially significant. Additional testing or avoidance of Site 22IS581 was recommended.

Carlisle-Tallula, Ms., Levee and Berm, Item #481.0-L

The Center for Archaeological Research at the University of Mississippi conducted a cultural resources survey of the entire 5.1 km (3.2 mi) length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Johnson 1981). The results of this inventory are described above. No cultural resources were located in the vicinity of the currently proposed project area.

R. Christopher Goodwin & Associates, Inc. conducted a Phase I cultural resources inventory of an approximate 1.1 km (0.7 mi) portion of the currently proposed 5.1 km (3.2 mi) long project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Weisman et al. 1994). The results of this survey are presented above. This survey identified only one site, 22IS581, that is located within the proposed Item #481.0-L project area.

As previously described in the discussion of Item #474.0-L, Site 22IS581 consisted of the foundations of a two story plantation house, a segment of a nineteenth century levee, a portion of the old river road, a possible slave cemetery, and a historic artifact scatter that may be associated with slave and later share croppers dwellings (Weisman et al. 1994). It was reported that the plantation house was constructed in 1833 and destroyed by a tornado in 1973. On the east side of the plantation house were the remains of two stores that supplied local share croppers. Site 22IS581 was assessed as potentially significant. Additional testing or avoidance of Site 22IS581 was recommended.

In addition, the St. James Church Cemetery was noted within the currently proposed project area. The cemetery is located on State Route 1 in the vicinity of Tallula, Mississippi. The only information obtained by R. Christopher Goodwin & Associates, Inc. on this cemetery is its location. This information was obtained exclusively from the Whiting Bayou, MS-LA USGS 7.5' topographic quadrangle.

Carlisle-Tallula, Ms., Levee and Berm, Item #486.0-L

As was previously described above, the Center for Archaeological Research at the University of Mississippi conducted a cultural resources survey of the entire 4.2 km (2.6 mi) length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Johnson 1981). The findings of this inventory are presented above. Pedestrian survey augmented by shovel testing identified one historic period site (Site 1). No official state site number was reported. The site, which is outside of the currently proposed project area, was assessed as not significant and no additional testing was recommended.

Carlisle-Tallula, Ms., Levee and Berm, Item #490.0-L

During June and July 1979, an approximately 1 km (0.5 mi) long portion of the currently proposed 4.4 km (2.7 mi) long project area was the subject of a Phase I cultural resources survey by the Center for Archaeological Research at the University of Mississippi (Sisson 1979). Sisson (1979) reported that the 2,593 ac (1,049 ha) survey area included 304.8 m (1,000 ft) from the center of the levee on both the landward side and the riverside between Levee Stations 6475+00 and 7000+00. Pedestrian survey identified two buried historic cemeteries and relocated the previously recorded Mayersville Site (22IS501). No official state site numbers were reported for the cemeteries. According to Sisson (1979), one cemetery was located west of Levee Station 6685 and the other was located west of Levee Station 6840 in a grove of trees. No evidence of the cemeteries was observed on the surface as silt covered the burials completely. The Mayersville Site (22IS501), which is discussed in detail in the discussion of Item #495.0-L, was assessed as potentially significant. Avoidance of Site 22IS501 and of the two cemeteries was recommended.

During July 1981, the entire 4.4 km (2.7 mi) length of the currently proposed project area was the subject of cultural resources inventory by the Center for Archaeological Research at the University of Mississippi at the request of the U.S. Army Corps of Engineers, Vicksburg District (Johnson 1981). The results of this survey are presented above. Pedestrian survey augmented by shovel testing identified one historic period site; however, no official state site number was reported. The site, which is located outside of the currently proposed project area, was assessed as not significant and no additional testing was recommended.

Valewood-Carlisle, Ms., Levee and Berm, Item #493.0-L

The Center for Archaeological Research at the University of Mississippi conducted a cultural resources survey of the entire 5 km (3.1 mi) length of the currently proposed project area during June and July, 1979 at the request of the U.S. Army Corps of Engineers, Vicksburg District (Sisson 1979). The results of this inventory are presented above.

Valewood-Carlisle, Ms., Levee and Berm, Item #495.0-L

As was discussed above, the Center for Archaeological Research at the University of Mississippi conducted a cultural resources survey of the entire 4.2 km (2.6 mi) length of the currently proposed project area during June and July, 1979 at the request of the U.S. Army Corps of Engineers, Vicksburg District (Sisson 1979). Pedestrian survey identified two buried historic cemeteries and relocated previously recorded Site 22IS501. No official state site numbers were reported for the cemeteries, and neither is located within the currently proposed project area. Site 22IS501 was assessed as potentially significant. Avoidance of the site and the two cemeteries was recommended. Site 22IS501 is located within the currently proposed Item #495.0-L project area.

Site 22IS501 originally was reported by Phillip Phillips in 1950 (Sisson 1979). The site was characterized as a prehistoric mound complex consisting of eleven mounds, two of which had been destroyed by plowing. It was suggested that the mounds were constructed during the Mayersville Phase (A.D. 1200-1400) and may have been reoccupied during the Deer Creek Phase (A.D. 1400-1600). An historic period family cemetery dating from 1865 - 1973 was noted on the summit of Mound B. Sisson (1979) assessed the site as potentially significant. Nomination of Site 22IS501 to the National Register of Historic Places and avoidance of the site was recommended.

Valewood-Carlisle, Ms., Levee and Berm, Item #497.0-L

The Center for Archaeological Research at the University of Mississippi conducted a cultural resources survey of the entire 3.6 km (2.2 mi) length of the currently proposed project area between June and July, 1979 on behalf of the U.S. Army Corps of Engineers, Vicksburg District (Sisson 1979). The results of this survey are provided above.

Valewood-Carlisle, Ms., Levee and Berm, Item #498.0-L

The Center for Archaeological Research at the University of Mississippi conducted a cultural resources survey of the entire 3.3 km (2.1 mi) length of the currently proposed project area between June and July of 1979 at the request of the U.S. Army Corps of Engineers, Vicksburg District (Sisson 1979). The results of this inventory are described above.

Carolina-Valewood, Ms., Levee, Item #502.0-L

During July 1980, R. Berry Lewis conducted a Phase I cultural resources survey of the entire 12.6 km (7.9 mi) length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Lewis 1980). According to Lewis (1980), the area surveyed was no less than 152 m (500 ft) to the landward side and no less than 305 m (1,000 ft) to the riverside of the center of the levee between Levee Stations 6075+00 and 6475+00. Pedestrian survey augmented by shovel testing identified five historic period archaeological sites (22IS553 - 22IS557). All of the sites were assessed as not significant. Although avoidance of these sites where it was feasible and practical to do so was recommended, no additional testing was recommended. Only Site 22IS555 was located within the proposed Item 502.0-L project area.

Site 22IS555 was described as a historic materials scatter dating from an undetermined period (Lewis 1980). Lewis (1980) suggested that the site may have been associated with several structures that appear on the 1933 Mississippi River Commission Map, but the only evidence observed of these structures was a light historic period artifact scatter. Site 22IS555 was assessed as not significant and no additional testing was recommended; however, avoidance of the site, if possible, was suggested.

Lake Jackson-Palmetto, Ms., Levee, Item #509.0-L

No cultural resources surveys or previously recorded sites were identified within the proposed Item #509.0-L project area. In addition, examination of the historic standing structure files failed to locate any standing structures or cemeteries within the proposed Item #509.0-L project area.

Lake Jackson-Palmetto, Ms., Levee, Item #511.0-L

One standing structure (151-LKW-7004-X) located within the proposed project area was identified at the Mississippi Department of Archives and History, Division of Historic Preservation, Jackson. The only information available regarding structure 151-LKW-7004-X (Everhope House) consisted of copies of photographs and a note indicating that the building burned to the ground in December 1992. From the photographs it appears that the chimneys and several of the walls were still standing after the fire. No assessment of the significance of structure 151-LKW-7004-X or additional information concerning the building was available.

James-Longwood, Ms., Levee and Berm, Item #521.0-L

No cultural resources inventories or previously recorded archeological sites or cemeteries were identified within the proposed Item #521.0-L project area. Additionally, an examination of the built resources files failed to identify any standing structures within the proposed Item #521.0-L project area.

Avon-Longwood, Ms., Berm, Item #524.0-L

No cultural resources inventories or previously recorded archeological sites or cemeteries were identified within the proposed Item #524.0-L project area. Additionally, an examination of the built resources files failed to identify any standing structures within the proposed Item #524.0-L project area.

Avon, Ms., Berm, Item #525.0-L

No cultural resources surveys or previously recorded sites or cemeteries were identified within the proposed Item #525.0-L project area. Moreover, examination of the standing structure files failed to identify any built resources within the proposed Item #525.0-L project area.

Avon, Ms., Levee and Berm, Item #526.0-L

No cultural resources inventories or previously recorded archeological sites were identified within the proposed Item #526.0-L project area. In addition, an examination of the standing structure files failed to identify any standing structures or cemeteries within the proposed Item #526.0-L project area.

Refuge, Ms., Berm, Item #531.0-L

During February and March, 1981, Brookes and Connaway conducted a cultural resources survey of the entire 1.4 km (0.9 mi) length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Connaway and Brookes 1981). Connaway and Brookes (1981) defined the survey area as 182 m (600 ft) to the landward side and 609.6 m (2000 ft) to the riverside of the levee centerline between Levee Stations 4417+50 and 4671+00 (1981). Pedestrian survey augmented by shovel testing, probing and borehole testing identified 12 historic period archeological sites. No official state site numbers were reported. Only the Griffin-Spragins House (151-GRU-5004) was assessed as significant. Avoidance of the Griffin-Spragins house and surrounding grounds was recommended. Although "Site 2" was not assessed as significant, avoidance of this site also was recommended. Since this survey was reported, the Griffin-Spragins house has been listed on the National Register of Historic Places.

Deerfield, Ms., Berm, Item #531.5-L

No cultural resources inventories or previously recorded archeological sites were identified within the proposed Item #531.5-L project area. Additionally, an examination of the standing structure files failed to identify any built resources or cemeteries within the proposed Item #531.5-L project area.

Warfield, Ms., Berm, Item #538.0-L

No cultural resources surveys or previously recorded sites or cemeteries were identified within the proposed Item #538.0-L project area. Moreover, examination of the standing structure files failed to locate any standing structures within the proposed Item #538.0-L project area.

Lagrange, Ms., Berm, Item #540.0-L

No cultural resources inventories previously recorded sites were identified within the proposed Item #540.0-L project area. In addition, examination of the historic standing structure files failed to identify any built resources or cemeteries within the proposed Item #540.0-L project area.

Above Greenville, Ms., Berm, Item #543.0-L

No cultural resources surveys or previously recorded archeological sites were identified within the proposed Item #543.0-L project area. Additionally, examination of the standing structure files failed to identify any standing structures or cemeteries within the proposed Item #543.0-L project area.

Below Catfish Point, Ms., Berm, #570.0-L

During April and May of 1986, Heartfield, Price and Greene, Inc., conducted a cultural resources survey of a 3.7 km (2.3 mi) long portion of the currently proposed 5.2 km (3.2 mi) long project area (Heartfield, Price and Greene, Inc. 1986). Heartfield Price and Greene, Inc. (1986) defined the proposed pipeline right-of-way as approximately 35.8 km (22.3 mi) in length and 18.3 m (60 ft) in width, for a total of 168 ac (68 ha). Pedestrian survey augmented by shovel testing and bankline survey identified 17 cultural resources loci (NLU-86-129 - NLU-86-145). No official state site numbers were reported for the loci. Two of the loci (NLU-86-129 and NLU-86-130) were described as historic cemeteries located outside of the pipeline right-of-way. All of the loci were assessed as not significant and no additional testing was recommended. The two cemeteries (NLU-86-129 and NLU-86-130) were located within the currently proposed project area and are discussed below.

Locus NLU-86-129 was characterized as an historic cemetery measuring 10 x 10 m (32.8 x 32.8 ft) and containing two marked graves, those of M. C. Martin (born November 3, 1825, died February 15, 1882) and Leroy C. Martin (born March 25, 1878, died August 31, 1883) (Heartfield, Price and Greene, Inc. 1986). The cemetery was bounded by an iron fence that had been disassembled and left on the site at the time of Heartfield, Price, and Greene, Inc.'s (1986) survey of the cemetery. The locus was assessed as not significant.

Heartfield, Price and Greene, Inc. (1986) described locus NLU-86-130 as an historic cemetery and a light historic materials scatter of undetermined historic cultural affiliation. The cemetery had been severely disturbed and no grave markers were observed to be *in situ*; however, Heartfield, Price and Greene, Inc. (1986) identified broken grave markers southwest of a barbed wire fence. The authors suggested that the grave markers had been moved so that the cemetery could be cultivated. The locus was assessed as not significant (Heartfield, Price and Greene, Inc. 1986).

Catfish Point, Ms., Berm, Item #571.0-L

No cultural resources inventories or previously recorded sites or cemeteries were identified within the proposed Item #571.0-L project area. In addition, examination of the historic standing structure files failed to identify any built resources within the proposed Item #571.0-L project area.

Upper Lake Bolivar, Ms., Berm, Item #575.0-L

No cultural resources surveys or previously recorded archeological sites were identified within the proposed Item #575.0-L project area. Additionally, an examination of the historic standing structure files failed to identify any built resources or cemeteries within the proposed Item #575.0-L project area.

Riverton, Ms., Berm, Item #585.0-L

No cultural resources inventories or previously recorded sites or cemeteries were identified within the proposed Item #585.0-L project area. Moreover, examination of the historic standing structure files failed to locate any standing structures within the proposed Item #585.0-L project area.

Rosedale, Ms., Berm, Item #589.0-L

No cultural resources surveys or previously recorded archeological sites or cemeteries were identified within the proposed Item #589.0-L project area. In addition, examination of the historic standing structure files failed to locate any built resources within the proposed Item #589.0-L project area.

Sledge-Waxhaw, Ms., Berm, Item #607.0-L

No cultural resources inventories previously recorded sites were identified within the proposed Item #607.0-L project area. Additionally, an examination of the historic standing structure files failed to identify any standing structures or cemeteries within the proposed Item #607.0-L project area.

Deeson, Ms., Berms, Item #611.0-L

No cultural resources surveys or previously recorded archeological sites were identified within the proposed Item #611.0-L project area. Moreover, examination of the historic standing structure files failed to locate any built resources or cemeteries within the proposed Item #611.0-L project area.

Round Lake, Ms., Berms, Item #614.0-L

No cultural resources inventories or previously recorded sites or cemeteries were identified within the proposed Item #614.0-L project area. In addition, an examination of the historic standing structure files failed to locate any standing structures within the proposed Item #614.0-L project area.

Francis, Ms., Berms, Item #616.0-L

No cultural resources surveys or previously recorded archeological sites were identified within the proposed Item #616.0-L project area. Additionally, examination of the historic standing structure files failed to identify any cemeteries or built resources within the proposed Item #616.0-L project area.

Arkansas

The Arkansas segment of the Vicksburg District portion of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS) project area includes 11 project items. The information presented here is based on documents currently on file at the Arkansas Archaeological Survey, Fayetteville, Arkansas and the Arkansas Historic Preservation Program, Little Rock, Arkansas.

Above Lakeport-Harwood, Ar., Levee and Berm, Item #520.0-R

On an unspecified date, the Center for Archaeological Research of the University of Mississippi conducted a cultural resources survey of a 0.4 km (0.2 mi) portion of the 4.3 km (2.7 mi) long currently proposed project area at the request of the U.S. Army Corps of Engineers, Vicksburg District (Binkley 1980). Pedestrian survey identified two historic artifact scatters. However, no official state site numbers were reported. The artifact scatters were assessed as not significant and no additional testing was recommended. Neither of the sites is located within the proposed Item #520.0-R project area.

During June, 1981, Coastal Environments, Inc. conducted a cultural resources survey of the entire 4.3 km (2.7 mi) length of the currently proposed project area at the request of the U.S. Army Corps of Engineers (Kelley 1981). Kelley (1981) defined the project area as 182.9 m (600 ft) to the landward side and up to 1219.2 m (4,000 ft) to the riverside of the levee along approximately 15 km (9.3 mi) of the present levee, for a total of 4,909 ac (1,988 ha). Pedestrian survey identified 41 historic period sites (3CH90-3CH130). Sites 3CH91, 3CH98, 3CH115, and 3CH121 were assessed as potentially significant, while Site 3CH90 was listed

on the National Register of Historic places prior to the Coastal Environments, Inc. survey. No recommendations for additional testing were reported. Avoidance of Site 3CH128, a historic cemetery, was recommended. Sites 3CH115, and 3CH117-3CH121 are located within the proposed Item #520.0-R project area and are discussed below.

Site 3CH115 consisted of an L-shaped frame structure with interior chimney house, a barn and three sheds scattered over an area encompassing approximately 5.3 ac (2.1 ha) (Kelley 1981). No artifacts were observed in the cultivated fields around the house. Due to the construction material and the number of outbuildings, Kelley suggested that the site represented a twentieth century tenant-renter residence (1981). Site 3CH115 was assessed as potentially significant. No recommendations for additional testing were reported.

Sites 3CH117-3CH120 were described historic artifact scatters formerly associated with cropper or tenant-renter houses dating from the nineteenth and twentieth century (Kelley 1981). These four sites were assessed as not significant and no additional testing was recommended.

Site 3CH121 consisted of one bungalow style house, one L-shaped house, a shed, two barns, three brick cisterns and an associated historic artifact scatter within a 15.6 ac (6.3 ha) area (Kelley 1981). According to Kelley, all of the structures dated to the twentieth century and seemed to be associated with two tenant-renter residences (1981). Two of the cisterns contained historic artifacts dating from the nineteenth and twentieth centuries. The third cistern was filled with dirt. Kelley determined that the cisterns dated to the mid-nineteenth century (1981). Due to the location of the resource, and the presence of artifacts and features, Kelley (1981) suggested that Site 3CH121 was part of the Florence Plantation. Site 4CH121 was assessed as potentially significant. No recommendations for additional testing were recommended.

<u>Above Lakeport-Harwood, Ar., Levee and Berm, Item #525.0-R</u>

Coastal Environments, Inc. conducted a cultural resources survey of the entire 5.1 km (3.2 mi) length of the currently proposed project area during June, 1981 at the request of the U.S. army Corps of Engineers (Kelley 1981). The results of this survey are described above. A total of nine sites, 3CH109, 3CH114, 3CH115, and 3CH122 - 3CH127, identified by Coastal Environments, Inc. are located within the proposed Item #525.0-R project area.

Sites 3CH109, 3CH114, and 3CH122 - 3CH127 were described as historic artifact scatters that once were associated with cropper or tenant-renter houses dating from the nineteenth and twentieth century (Kelley 1981). These eight sites were all assessed as not significant and no additional testing was recommended.

As previously described with Item #520.0-R, Site 3CH115 consists of an L-shaped frame structure with interior chimney house, a barn and three sheds scattered over an area encompassing 5.3 ac (2.1 ha) (Kelley 1981). No artifacts were observed in the cultivated fields around the house. Due to the construction material and the number of outbuildings, Kelley suggested that the site represented a twentieth century tenant-renter residence (1981). Site 3CH115 was assessed as potentially significant. No recommendations for additional testing were reported.

According to the Arkansas Historic Preservation Program, Standing Structure CH0154 was located within the proposed Item #525.0-R project area. The Lake Port House (CH0154) was described as a two-story, Plain/Traditional with Craftsman detail style, frame house with a hip and gable shingles roof dating from circa 1915. In addition to the house, a well was associated with the site. No assessment of significance of Standing Structure CH0154 or recommendations for testing were reported.

Above Lakeport-Harwood, Ar., Levee and Berm, Item #528.0-R

As was described above, Coastal Environments, Inc. conducted a cultural resources survey of the entire 4.6 km (2.9 mi) length of the currently proposed project area during June, 1981 at the request of the U.S. Army Corps of Engineers (Kelley 1981). The results of this inventory are presented above. This survey identified 16 sites within the current project area. Sites 3CH90 - 3CH95, 3CH97 - 3CH99, 3CH102, 3CH104 - 3CH107, 3CH109 and 3CH110 were located within the proposed Item #528.0-R project area.

Site 3CH90, the Lakeport Plantation, consisted of a main house, tenant houses, outbuildings associated with a light historic artifact scatter dating from the nineteenth century to the twentieth century (Kelley 1981). According to the Arkansas Historic Preservation Survey, the Lakeport Plantation main house (Standing Structure #CH0007) was listed on the on the National Register of Historic Places by Anthony Riddle in 1974. Built ca. 1850, the Lakeport Plantation main house was described as a two-story frame construction house with a two-story portico designed in Greek Revival style. No recommendations for recordation were provided.

Site 3CH91 was described as an historic artifact scatter that may represent the remains of slave quarters and/or cropper houses associated with the Lakeport Plantation (Kelley 1981). Although the site had been cultivated for a considerable period of time, Kelley suggested that intact deposits may exist below the plowzone (1981). Site 3CH91 was assessed as potentially significant. No recommendations for additional testing were reported.

Sites 3CH92, 3CH95, 3CH97, 3CH99, 3CH102, 3CH104 - 3CH107, 3CH109, and 3CH110 were characterized as nineteenth and twentieth century historic artifact scatters associated with cropper or tenant-renter houses that were no longer extant (Kelley 1981). All of these sites were assessed as not significant and no additional testing was recommended.

Site 3CH93 was described as a twentieth century cropper or neoplantation worker house and historic artifact scatter (Kelley 1981). Site 3CH93 was assessed as not significant and no additional testing was recommended.

Site 3CH94 was characterized as an historic artifact scatter possibly associated with a cotton gin that was no longer extant (Kelley 1981). Kelley assessed Site 3CH94 as not significant and no additional testing was recommended (1981).

Site 3CH98 consists of a clapboard frame house, privy and associated artifact scatter dating from the twentieth century and covering an approximately 0.4 ac (0.16 ha) area (Kelley 1981). Information about the house is also on file at the Arkansas Historic Preservation Program under the name Lakeport Vicinity House (Standing Structure #CH0153). According to Kelley, the double-pen structure house with a single interior chimney and historic artifact scatter represented a cropper and neoplantation house. During the Coastal Environments, Inc. survey of the site, no subsurface testing was conducted; thus the depth of cultural material was unknown (Kelley 1981). Site 3CH98 was assessed as potentially significant. No recommendations for additional testing of Site 3CH98 were reported.

Sunnyside, Ar., Levee, Item #531.0-R

No cultural resources surveys or previously recorded archeological sites were identified within the proposed Item #531.0-R project area. In addition, an examination of the historic architecture files at the Arkansas Historic Preservation Program failed to identify any standing structures or cemeteries within the proposed Item #531.0-R project area.

Leland-Vaucluse, Ar., Levee and Berm, Item #536.0-R

No cultural resources inventories or previously recorded archeological sites or cemeteries were identified within the proposed Item #536.0-R project area. Moreover, an examination of the historic architecture files at the Arkansas Historic Preservation Program failed to identify any standing structures within the proposed Item #536.0-R project area.

Luna-Leland, Ar., Levee and Berm, Item #541.0-R

According to the Arkansas Historic Preservation Program, the Columbia Community Site (CH0010) was located in the vicinity of the proposed Item #541.0-R project area. Columbia was the second Chicot County seat. Although the exact location of the community was unknown, the Inventory Form stated that the site may have been destroyed by erosion or levee construction. No assessment of significance or recommendations were reported by C. L. Bond in 1972 on the Arkansas Historic Preservation Survey Inventory Form.

Panther Forest, Ar., Berm, Item #543.0-R

No cultural resources surveys or previously recorded archeological sites or cemeteries were identified within the proposed Item #543.0-R project area. Additionally, examination of the historic architecture files at the Arkansas Historic Preservation Program failed to identify any standing structures within the proposed Item #543.0-R project area.

Gaines Landing, Ar., Berm, Item #546.0-R

No cultural resources inventories or previously recorded archeological sites were identified within the proposed Item #546.0-R project area. In addition, an examination of the historic architecture files at the Arkansas Historic Preservation Program failed to identify any standing structures or cemeteries within the proposed Item #546.0-R project area.

Dewey, Ar., Berm, Item #548.0-R

No cultural resources surveys or previously recorded archeological sites were identified within the proposed Item #548.0-R project area. Moreover, an examination of the historic architecture files at the Arkansas Historic Preservation Program failed to identify any cemeteries or standing structures within the proposed Item #548.0-R project area.

Below Arkansas City, Ar., Levee, Item #555.0-R

No cultural resources inventories or previously recorded archeological sites or cemeteries were identified within the proposed Item #555.0-R project area. Additionally, examination of the historic architecture files at the Arkansas Historic Preservation Program failed to identify any standing structures within the proposed Item #555.0-R project area.

Cypress Creek, Ar., Berm, Item #576.0-R

Site 3DE129 was located within the proposed Item #575.0-R project area. In December, 1989, Site 3DE129 was identified during a cultural resources survey of a proposed Texas Gas Transmission Gasline sponsored by the Research Program of the Arkansas Archaeological Survey (Mintz 1990). Fieldwork consisted of pedestrian survey and limited shovel testing. The site was described as an historic artifact scatter dating from the twentieth century. Mintz (1990) suggested that Site 3DE129 represented an abandoned and demolished tenant house. Site 3DE129 was assessed as not significant and no additional testing was recommended.

Additionally, the Cypress Bend Battle Site (DE0087) was located in the vicinity of the Item #576.0-R; however, a map of its location was not provided on the Arkansas Historic Inventory Form. According to the Arkansas Historic Preservation Program, the battle site was located at Cypress Creek and Boggy Bayou, probably near Possum Fork. On February 18, 1863, the Federals attacked Confederate guerrillas who were harassing river traffic at this site. No assessment of significance or recommendations for additional testing were reported by C.L. Bond in 1971 on the Arkansas Historic Preservation Survey Inventory Form.

Proposed SEIS Project Items Located Within the U.S. Army Corps of Engineers, Memphis District

The Memphis District portion of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS) includes project items within the states of Mississippi, Arkansas, Tennessee, Kentucky, Missouri, and Illinois (Tables 5 - 8). These proposed project items are presented by state below.

Mississippi

This section presents the preliminary results of a literature and records review for the Mississippi portion of the Memphis District segment of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS). The information presented here is based on a search of background information currently on file at the Mississippi Department of Archives and History, Jackson, Mississippi. The U.S. Army Corps of Engineers, Memphis District, portion of the SEIS includes three items in Mississippi.

<u>Hillhouse Relief Wells</u>

During 1985, Coastal Environments, Inc. of Baton Rouge, Louisiana, conducted a Phase I cultural resources survey within the vicinity of Sunflower Landing, Coahoma County, Mississippi, at the request of the U.S. Army Corps of Engineers, Memphis District, prior to proposed berm construction (Weinstein et al. 1985). The survey area included an approximately 0.6 km (0.4 mi) long portion of the currently proposed approximately 9 km (5.6 mi) long Hillhouse Relief Wells project area. Pedestrian survey augmented by limited shovel testing, auger testing, unit excavation, and magnetometer survey resulted in the identification of 16 archeological sites (22CO704 - 22CO719). Of these, sites 22CO713, 22CO715, and 22CO719 were assessed as significant and avoidance during proposed construction was recommended. Weinstein et al. (1985) reported that National Register of Historic Places nomination forms had been submitted for these sites.

Of the remaining sites, Site 22CO704 was assessed as potentially significant; however, Weinstein et al. (1985) reported that the site was located outside the proposed project area and would not be impacted adversely by proposed construction. Sites 22CO705, 22CO707 - 22CO712, 22CO714, and 22CO716 - 22CO718 were assessed as not significant and no additional testing was recommended. The final site (22CO706) was not assessed by Weinstein et al. (1985) as it was reported to be located outside the proposed construction area. None of 16 sites identified by Weinstein et al. (1985) was located within the currently proposed Hillhouse Relief Wells project area.

Table 5. Cultural Resource Surveys within the Proposed SEIS Project Items, U.S. Army Corps Engineers, Memphis District.

FIELD DATE	REPORT NUMBER	TITLE/AUTHOR	PROJECT DESCRIPTION	RESULTS AND RECOMMENDATIONS
MISSISSIPPI				
1985	Not Available	Cultural Resources Survey in the Vicinity of Sunflower Landing: Investigations Related to the Rena Lara Landside Berm, Item L-628, Coahoma County, Mississippi (Weinstein et al. 1985)	Records review, pedestrian survey, shovel testing, auger testing, unit excavation, and magnetometer survey	Identified Sites 22CO704 - 22CO719. Sites 22CO713, 22CO715, and 22CO719 were assessed as significant and avoidance during proposed construction was recommended.
ARKANSAS				
1979	295	An Archaeological, Architectural, and Historical Resources Survey of 21 Mississippi River Levee Berm Items, Crittenden and Desha Counties, Arkansas: Component 6 (Nixon et al. 1982)	Pedestrian survey	Identified 110 standing structures and 30 archeological sites. Site 3CT3 was assessed as potentially significant while it was recommended that sites 3CT6, and 3DE81be avoided by proposed construction.
1980	995	An Archaeological and Historical Resources Survey of 21 Mississippi River Levee Berm Items: Northeast Arkansas and Southeast Missouri (Nixon et al. 1981)	Pedestrian survey	Identified 153 standing structures and seven archeological sites (23PM565 - 23PM567, 3MS384 - 3MS387). None were assessed as significant but avoidance of Sites 23PM565 and 3MS385 was recommended.
1981	585	An Archeological Survey of the Proposed Sewer Improvement Project Area for the City of West Memphis, Crittenden County, Arkansas (Waddell 1981)	Pedestrian survey, shovel testing, and limited unit excavation	Identified Sites 3CT206 - 3CT210 and one isolated find. None of the sites were assessed as significant and no additional testing was recommended.
1983	412	Cultural Resources Intensive Survey and Testing of Mississippi River Levee Berms, Crittenden and Desha Counties, Arkansas ..., Contract #DACW66-83-C-0030, Item R-606, Henrico; Desha County, Arkansas (Heartfield, Price and Greene, Inc. 1984)	Records review, pedestrian survey, shovel testing, and unit excavation	Identified 13 sites (3DE96 - 3DE108) and relocated previously recorded Site 3DE21. None of the sites was assessed as significant but monitoring of Site 3DE21 during proposed construction was recommended.
TENNESSEE				
1979	01199	Draft Report: An Archaeological and Historical Resources Survey of 21 Mississippi River Levee Berm Items in the States of Kentucky and Tennessee: Item 1 (McNerney and Nixon 1980)	Records review, pedestrian survey, and shovel testing	Identified 25 historic sites, and 9 prehistoric sites. Only Sites 40LK7, 40LK19, 40LK21 and 40LK27 were assessed as potentially significant. Recommended additional testing for sites 40LK19 and 40LK21 and avoidance of sites 40LK7 and 40LK27.
1979	02900	Draft Report: An Architectural Resources Survey of 21 Mississippi River Levee Berm Items in the States of Kentucky and Tennessee: Component 1 (White 1980)	Records review, informant interviews, and pedestrian survey	Identified 177 architectural and structural features. Only Site 1-f-6 was assessed as potentially significant and additional research was recommended.
1979	01199	Final Report: An Archaeological, Architectural and Historical Resources Survey of 21 Mississippi River Levee Berm Items in the States of Kentucky and Tennessee: Component 1 (Nixon 1982)	Records review, pedestrian survey, shovel testing, and interview informants	Identified 25 historic sites, 9 prehistoric sites, and 185 standing structures. Of all the sites and structures, only Sites 40LK7 and 40KL27 were assessed as potentially significant for which additional testing was recommended.

Table 5. Cultural Resource Surveys within the Proposed SEIS Project Items, U.S. Army Corps Engineers, Memphis District.

FIELD DATE	REPORT NUMBER	TITLE/AUTHOR	PROJECT DESCRIPTION	RESULTS AND RECOMMENDATIONS
KENTUCKY				
1979	01199	Draft Report: An Archaeological and Historical Resources Survey of 21 Mississippi River Levee Berm Items in the States of Kentucky and Tennessee: Item 1 (McNerney and Nixon 1980)	Records review, pedestrian survey, and shovel testing	Identified 25 historic sites, and 9 prehistoric sites. Only Sites 40LK7, 40LK19, 40LK21 and 40LK27 were assessed as potentially significant. Recommended additional testing for sites 40LK19 and 40LK21 and avoidance of sites 40LK7 and 40LK27.
1979	02900	Draft Report: An Architectural Resources Survey of 21 Mississippi River Levee Berm Items in the States of Kentucky and Tennessee: Component 1 (White 1980)	Records review, interview informants, and field methods were not reported	Identified 177 architectural and structural features. Only Site 1-f-6 was assessed as potentially significant and additional research was recommended.
1979	01199	Final Report: An Archaeological, Architectural and Historical Resources Survey of 21 Mississippi River Levee Berm Items in the States of Kentucky and Tennessee: Component 1 (Nixon 1982)	Records review, pedestrian survey, shovel testing, and interview informants	Identified 25 historic sites, 9 prehistoric sites, and 185 standing structures. Of all the sites and structures, only Sites 40LK7 and 40KL27 were assessed as potentially significant for which additional testing was recommended.
MISSOURI				
1977	MI011	An Intensive Cultural Resources Survey and Assessment of Proposed Levee Modification at Item No. R-925, Dorena, Mississippi County, Missouri (McNerney and Fischer 1978)	Records review and pedestrian survey	Identified the historic Allen Cemetery. The cemetery was assessed as not significant; however, avoidance during proposed construction was recommended.
1979 & 1980	CG006	An Archaeological and Historical Resources Survey of 21 Mississippi River Levee Berm Items: Component 2, Southeast Missouri (Nixon 1980)	Records review, pedestrian survey, and pedestrian survey	Identified Sites 23CG51 - 23CG53 and 23ST184 - 23ST191. Of these, Site 23ST189 was assessed as significant and avoidance was recommended. Sites 23ST187 and 23ST191 were assessed as potentially significant; additional testing was recommended.
1980	Not Available	An Archaeological and Historical Resources Survey of 21 Mississippi River Levee Berm Items: Component 5, Northeast Arkansas and Southeast Missouri (Nixon et al. 1981)	Records review and pedestrian survey	Identified 153 standing structures and seven archeological sites (23PM565 - 23PM567, 3MS384 - 3MS387). None were assessed as significant but avoidance of Sites 23PM565 and 3MS385 was recommended.
1980	MI019	Phase I Cultural Resources Surveys, Mississippi County (Kross 1981)	Records review and pedestrian survey	Identified Bridge Z-754 and a standing structure in the vicinity of the currently proposed project area. Neither was assessed as significant; no additional testing was recommended.
1980	MI020	An Archaeological and Historical Resources Survey of the 21 Mississippi River Levee Berm Items, Component 4, New Madrid Floodway (Nixon 1982)	Records review and pedestrian survey	Identified 59 archeological sites and 272 architectural features. Of these, 12 were assessed as potentially significant and additional testing was recommended. Site 23MI1 had previously listed on the National Register.

Table 5. Cultural Resource Surveys within the Proposed SEIS Project Items, U.S. Army Corps Engineers, Memphis District.

FIELD DATE	REPORT NUMBER	TITLE/AUTHOR	PROJECT DESCRIPTION	RESULTS AND RECOMMENDATIONS
1980	MI021	A Cultural Resources Survey of Levee Repair Item No. R-916R, Mississippi and New Madrid Counties, Missouri (Prescott 1980)	Records review and pedestrian survey	No cultural resources were identified; no additional testing was recommended.
1982	Not Available	Letter Report. Subject: Cultural Resources Survey at Slide Repair Mi. 9/10, Samos, Mississippi County, Missouri (Grosso 1982)	Pedestrian survey	Identified Site 23MI596 outside of the proposed borrow pit area. The site was not assessed; however, it was recommended no borrowing take place in the vicinity of Site 23MI596.
1983	MI023	A Survey Report of the Bird's Point-New Madrid Floodway Inflow/Outflow Crevasse #1 and Crevasse #2 Project Areas, New Madrid and Mississippi Counties, Missouri (Kekkonan and Martin 1983)	Records review, pedestrian survey, and shovel testing	Identified historic period locus C#2#1 in the vicinity of the currently proposed project area. The locus was assessed as not significant and no additional testing was recommended.
1983	CG022	Cultural Resources Intensive Survey and Testing of the Mississippi River Levee Berms, ..., Scott, Cape Girardeau and Pemiscot Counties, Missouri, Contract #DACW66-83-C-0030, Item R-846 Caruthersville; Pemiscot County, Missouri (HPG, Inc. 1983)	Records review, pedestrian survey, and shovel testing	Identified six sites (23PM569, 23PM570, NLU-83-69, -80, -83, and -85) and 173 standing structures. None were assessed as significant; however, one (Caruthersville Water Tower) was previously listed on the National Register.
1986 & 1987	MI028	St. John's Bayou, Cultural Resources Survey and Testing in Scott, Mississippi and New Madrid Counties, Missouri (Klinger et al. 1988)	Records review, pedestrian survey, and shovel testing	Identified Site 23MI601 and 23MI602 within the vicinity of the currently proposed project area. Neither was assessed as significant; no additional testing was recommended.
1991 & 1992	NM030	Cultural Resource Investigations, Donaldson Point State Forest, New Madrid County, Missouri (Sturdevant 1992)	Records review and pedestrian survey	Identified previously recorded sites 23NM234 and 23NM506. Both sites were assessed as potentially significant and avoidance during proposed construction was recommended.
1995	CG050	Nash Relief Wells (Sierzchula 1996)	Records review, pedestrian survey, and shovel testing	Identified three sites (23CG213 - 23CG215) within the vicinity of the currently proposed project area. Sites 23CG214 and 23CG215 were assessed as potentially significant; additional testing or avoidance was recommended.
ILLINOIS				
1980	882	An Archaeological and Historical Resources Survey of 21 Mississippi River Berm Items: Component 3, Southernmost Illinois (Nixon 1980)	Records review, pedestrian survey, and shovel testing.	Identified 227 architectural resources and 4 archaeological sites. None of the architectural resources or the archaeological sites were considered significant. No additional testing was recommended.

Table 5. Cultural Resource Surveys within the Proposed SEIS Project Items, U.S. Army Corps Engineers, Memphis District.

FIELD DATE	REPORT NUMBER	TITLE/AUTHOR	PROJECT DESCRIPTION	RESULTS AND RECOMMENDATIONS
1980	763	Archaeological Reconnaissance of the Lower Ohio River Navigation Area, Illinois and Kentucky (Watson 1981)	Pedestrian survey and shovel testing	Identified 53 archaeological sites and relocated 3 prerecorded sites. Five sites were potentially significant and recommended for additional work (11PU140, W-595-1, W-595-24, W-595-39, and W-595 56).
1985-1986	967	Cultural Resources Investigations and Assessment of the Mound City Shipyard and Marine Ways(11PU140), Pulaski County, Illinois (Goodwin and Jones 1986)	Records review, interviews, surface collection and unit excavation	The site, 11PU140, demonstrated enough merit to warrant consideration for NRHP status. However, the significant portions of the site remained outside of the impact area; construction was allowed if the site was avoided.

Table 6. Previously Recorded Sites within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Memphis District.

SITE NUMBER	USGS 7.5' QUADRANGLE	SITE DESCRIPTION	CULTURAL AFFILIATION	FIELD METHODOLOGY	NRHP ELIGIBILITY	RECORDED BY
ARKANSAS						
3CT109	Edmondson	Prehistoric period material scatter	Mississippian	Pedestrian survey	Not significant	Nixon 1979
3DE21	Snow Lake	Three historic flood refuge mounds	Late 19th - Early 20th century	Pedestrian survey, shovel testing, unit excavation, and auger testing	Not significant	Lueken 1969; Madden 1983
3DE96	Snow Lake	Historic flood refuge mound and standing structures	Late 19th - late 20th century	Pedestrian survey and shovel testing	Not significant	Madden 1983
3DE103	Snow Lake	Historic period material scatter	ca. post World War I	Pedestrian survey, shovel testing, and unit excavation	Not significant	Madden 1983
3DE109	Laconia	Historic farm complex with 6 standing structures	Mid - late 20th century historic period	Pedestrian survey	Not significant	Clendenen 1983
KENTUCKY						
15FU34	Bondurant	Historic period material scatter	ca. 1800 -1900	Pedestrian survey	Not significant	Nixon 1979
15FU35	Bondurant	Historic period material scatter	ca. 1800 -1900	Pedestrian survey	Not significant	Nixon 1979
15FU36	Bondurant	Two historic structures	ca. 1800 -1900	Pedestrian survey	Not significant	Nixon 1979
MISSOURI						
23CG53	Chaffee	Prehistoric period and historic period material scatter	Prehistoric: Baytown period; Historic:pre-1920	Not reported	Not significant	Nixon 1979
23CG215	Chaffee	Prehistoric period material scatter	Prehistoric:Archaic period	Pedestrian survey	Potentially significant	Sierzchula 1996
23MI1	Wickliffe SW	Crosno Fortified Village: prehistoric mound and village	Middle Baytown period -Late Mississippi period	Not reported	Listed to National Register in 1969	Born 1969
23MI70	Wolf Island	Prehistoric period material scatter and isolated historic find	Prehistoric: Baytown period or possible Mississippi period	Pedestrian survey	Potentially significant	Williams 1967; Nixon 1981
23MI135	Wickliffe SW	Prehistoric period and historic period material scatter	Prehistoric: Baytown period -mid Mississippi period	Pedestrian survey	Potentially significant	Nixon 1981

Table 6. Previously Recorded Sites within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Memphis District.

SITE NUMBER	USGS 7.5' QUADRANGLE	SITE DESCRIPTION	CULTURAL AFFILIATION	FIELD METHODOLOGY	NRHP ELIGIBILITY	RECORDED BY
23MI558	Wickliffe SW	Prehistoric period material scatter and isolated historic find	Undetermined prehistoric period; undetermined historic period	Pedestrian survey	Not significant	Nixon 1981
23MI560	Wickliffe SW	Prehistoric period and historic period material scatter	Prehistoric: Baytown period; Historic: ca. 1825-1960	Pedestrian survey	Not significant	Nixon 1981
23MI568	Anniston	Prehistoric period material scatter	Baytown period	Pedestrian survey	Potentially significant	Nixon 1981
23MI562	Anniston	Historic period material scatter	ca. 1855-1920	Pedestrian survey	Not significant	Nixon 1981
23MI571	Anniston	Prehistoric period and historic period material scatter	Late Mississippi period; Historic; 1880- present	Pedestrian survey	Not significant	Nixon 1981
23MI572	Anniston	Prehistoric period material scatter	Baytown period	Pedestrian survey	Potentially significant	Nixon 1981
23MI573	Anniston	Historic period material scatter	ca. 1825-recent historic period	Pedestrian survey	Not significant	Nixon 1981
23MI574	Anniston	Prehistoric period material scatter	Baytown period	Pedestrian survey	Not significant	Nixon 1981
23MI577	Anniston	Prehistoric period material scatter	Archaic and Baytown period	Pedestrian survey	Potentially significant	Nixon 1981
23MI587	Wickliffe SW	Historic period material scatter	ca. 1820-1900+	Pedestrian survey	Not significant	Nixon 1981
23MI597	Wolf Island	Historic period material scatter	Mid-20th century	Pedestrian survey, shovel testing, and excavation of test unit	Not significant	Heartfield, Price and Greene, Inc. 1984
23NM506	Hubbard Lake	Not reported	Not reported	Pedestrian survey	Potentially significant	Not reported
23NM534	Hubbard Lake	Historic period material scatter	ca. 1855-1920	Not reported	Not significant	Nixon 1981
23PM84	Caruthersville	Historic period material scatter	Undetermined historic	Pedestrian survey	Not reported	Stinson 1978
23PM566	Cottonwood Point	Historic period artifact scatter	ca. 1830-present	Pedestrian survey	Not significant	Nixon 1980
23PM567	Cottonwood Point	Historic period artifact scatter	ca. 1850-1920	Pedestrian survey	Not significant	Nixon 1980
23ST186	Thebes SW	Historic period material scatter	Late 19th-early 20th century	Not reported	Not significant	Nixon 1980; Meyer 1997

Table 6. Previously Recorded Sites within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Memphis District.

SITE NUMBER	USGS 7.5' QUADRANGLE	SITE DESCRIPTION	CULTURAL AFFILIATION	FIELD METHODOLOGY	NRHP ELIGIBILITY	RECORDED BY
23ST187	Thebes	Prehistoric period material scatter	Early Baytown and Mississippian periods	Pedestrian survey	Potentially significant	Nixon 1980; Meyer 1997
23ST189	Thebes SW	Prehistoric period and historic period material scatter	Late Baytown and Mid-Late Missippian periods	Pedestrian survey	Potentially significant	Nixon 1980; Meyer 1997
23ST190	Thebes SW	Prehistoric period material scatter and a historic isolated find	Prehistoric: Middle-Late Baytown period; Undetermined historic period	Pedestrian survey	Not significant	Nixon 1980; Meyer 1997
ILLINOIS						
11AX228	Cairo	Historic period material scatter	Mid to late nineteenth century	Pedestrian survey and shovel testing	Not significant	Nixon 1980
11PU140	Cairo	Historic shipyard	Mid-19th to mid-20th century	Pedestrian survey with shovel and auger testing, and unit excavation	Potentially significant	Pulcher 1973
11PU217	Cairo	Historic public landing	Early to mid-20th century	Records review, pedestrian survey, and shovel testing	Not significant	Watson 1981

Table 7. Standing Structures within the Proposed SEIS Project Items, U.S. Army Corps of Engineers Memphis District.

STANDING STRUCTURE NO.	ADDRESS	TYPE	DATE RANGE
ARKANSAS			
DE0073	Vicinity of Snow Lake, AR	Laconia Circle Levee	Early 1800s
DE0074	Vicinity of Snow Lake, AR	Kappa Indian Village	pre ca. 1682
MS0095	Vicinity of Bulter, AR	Former location of Social Bend House	Not reported
KENTUCKY			
FU22 (1-a-9)	Vicinity of Hickman, KY	Ottis Lewis Farmstead	Early-mid-20th century
MISSOURI			
5-a-1	Vicinity of McCarty, MO	Residence	Early/mid-20th century
5-a-2	Vicinity of McCarty, MO	Residence	Early/mid-20th century
5-a-3	Vicinity of McCarty, MO	Riverland Plantation	Early/mid-20th century
5-a-4	Vicinity of McCarty, MO	Mclanahan Tenant Places	Mid-20th century
5-a-5	Vicinity of McCarty, MO	Calvin Dunavant Place	Mid-20th century
5-a-6	Vicinity of McCarty, MO	Residence	Early/mid-20th century
5-a-7	Vicinity of Cottonwood Point, MO	Residence	Mid-20th century
5-a-10	Vicinity of Cottonwood Point, MO	Agricultural	Mid-20th century
5-a-12	Cottonwood Point, MO	Residence	Early/mid-20th century
5-a-15	Cottonwood Point, MO	Baker Tenant Place	Early/mid-20th century
5-a-16	Cottonwood Point, MO	Residence	Mid-20th century
5-a-18	Cottonwood Point, MO	Baker Tenant Place	Mid-20th century
5-a-19	Vicinity of Cottonwood Point, MO	Residence	Mid-20th century
5-a-20	Vicinity of Cottonwood Point, MO	Residence	Mid-20th century
5-a-21	Vicinity of Cottonwood Point, MO	William J. Smith Farmstead	Early/mid-20th century
5-a-22	Vicinity of Cottonwood Point, MO	Residence	Early/mid-20th century
5-a-23	Vicinity of Cottonwood Point, MO	Residence	Early/mid-20th century
5-a-24	Vicinity of Cottonwood Point, MO	J.M. Fitzmaurice Farmstead	Mid-20th century
5-a-26	Vicinity of Tyler, MO	Shaw Tenant Place	Early/mid-20th century
ILLINOIS			
3-a-82	Cairo, IL.	Illinois Central Railroad Bridge	Late 19th-mid-20th century

Table 8. Cemeteries within the Proposed SEIS Project Items, U.S. Army Corps of Engineers, Memphis District.

CEMETERY NAME	ADDRESS	TYPE	DATE RANGE
MISSOURI			
Taylor Cemetery (23PM565)	Vicinity of Cottonwood Point, Missouri	Historic	ca. 1890 - 1920
Allen Cemetery	North of Levee Mile 56/42+10	Historic	Unknown

Trotters Seepage Berm

No cultural resources surveys or previously recorded sites were identified within the proposed Trotters Seepage Berm project area. Additionally, examination of the standing structure files failed to identify any built resources or cemeteries within the proposed Trotters Seepage Berm project area.

Austin Relief Wells

No cultural resources inventories or previously recorded sites were identified within the proposed Austin Relief Wells project area. Additionally, examination of the standing structure files failed to locate any built resources or cemeteries within the proposed Austin Relief Wells project area.

Arkansas

The Arkansas portion of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS), Memphis District includes eight project items. A background search of information currently on file at the Arkansas Archeological Survey, Fayetteville, Arkansas, and the Arkansas Historic Preservation Program, Little Rock, Arkansas was conducted to complete this portion of the records search. Information pertaining to cultural resource surveys and previously recorded archeological sites, standing structures, and cemeteries identified within the proposed project areas is presented below.

Henrico Seepage Berm

The entire currently proposed Henrico Seepage Berm project area was subjected to Phase I cultural resources survey during 1983 by Heartfield, Price, and Greene, Inc. of Monroe, Louisiana (Heartfield, Price, and Greene, Inc. 1984). Pedestrian survey augmented by shovel testing and limited unit excavation identified Sites 3DE96 - 3DE108. In addition, one previously recorded site (3DE21) was reinvestigated. None of the sites were assessed as significant and no additional testing was recommended, but archeological monitoring of Site 3DE21 during proposed construction was recommended to collect data relevant to the construction of historic period flood refuge mounds. Of the 14 sites identified and/or examined by Heartfield, Price, and Greene, Inc. (1984), Sites 3DE21, 3DE96, and 3DE103 are located within the currently proposed Henrico Seepage Berm project area and are discussed below.

Site 3DE21 is completely contained within Henrico Seepage Berm #3. The site was recorded by John Lueken in 1969. Lueken described the site as a possible Mississippian period mound; however, Lueken noted that an examination of the site was not conducted because the landowner refused to grant permission for testing. Heartfield, Price, and Greene, Inc. (1984) reexamined Site 3DE21 in 1983 and reported that the mound noted by Lueken during 1969 represented a historic flood refuge mound dating from the late nineteenth - late twentieth century and a post 1930 house location. Site 3DE21 was assessed as not significant, but Heartfield, Price, and Greene, Inc. (1984) recommended that an archeologist monitor proposed construction in the vicinity of the historic mound to obtain information about the construction of flood refuge mounds.

Site 3DE96 was described as a complex of seven primary standing structures and eight service structures. In addition, a flood refuge mound of historic period construction was identified at Site 3DE96. Henrico Seepage Berm #1 is located completely within the reported boundaries of Site 3DE96. Heartfield, Price, and Greene, Inc. (1984) reported that the site dated from the late nineteenth - late twentieth century. Site 3DE96 was assessed as not significant and no additional testing was recommended.

Site 3DE103 was located partially within the confines of Henrico Seepage Berm #3. Heartfield, Price, and Greene, Inc. (1984) described the site as a surface scatter of historic materials. It was suggested that Site 3DE103 represented a post-1915 residence location. It addition, Heartfield, Price, and Greene, Inc. (1984) reported that the residence had been destroyed ca. 1963. Site 3DE103 was assessed as not significant and no additional testing was recommended.

A review of the architectural files at the Arkansas Historic Preservation Program identified two cultural resources (DE0073 and DE0074) within the immediate vicinity of the Henrico Seepage Berm project area. These two cultural resources also were noted within the immediate vicinity of the Knowlton Seepage Berm. A portion of the Laconia Circle Levee (DE0073) is included within the currently proposed project area. The Laconia Circle Levee was recorded by Jim Merritt in 1979 and was reported to date from the early 1800s. Although the Arkansas Historic Preservation Program suggests that the resource possesses historic significance on a "state" level, the site has not been formally assessed.

The reported location of Kappa Indian Village (DE0074) was noted adjacent to the south and east sides of the Laconia Circle Levee (DE0073). The area (DE0074) was recorded by Jim Merritt in 1979 and was described as the northern most village of the Arkansas Indians. Although the Arkansas Historic Preservation Program Inventory Form suggests that the resource possesses historic significance on a "national" level, the site has not been formally assessed.

Knowlton Seepage Berm

The currently proposed Knowlton Seepage Berm was subject to Phase I cultural resources survey in 1979 by American Resources Group, Ltd. of Carbondale, Illinois (Nixon et al. 1982). Pedestrian survey of the Knowlton Levee between Mile 52/52+00 - Mile 57/0+00 by Nixon et al. (1982) identified seven archeological sites (3DE77 - 3DE83) and seven standing structure complexes (6-c-1, 6-c-2a - 6-c-2e, and 6-c-3). None of the seven sites or the seven standing structure complexes were assessed as significant. No additional testing was recommended, but it was suggested that Site 3DE81 (White Parker Cemetery) be avoided during proposed construction. None of the cultural resources identified by Nixon et al. (1982) were located within the currently proposed Knowlton Seepage Berm.

A total of one site (3DE109) was identified within the boundary of proposed Knowlton Seepage Berm #3. The site was recorded by N. Clendenen in 1983 and was described as a farm complex consisting of a residence and five service structures. Site 3DE109 was assessed as not significant and no additional testing was recommended. It should be noted that Site 3DE109 was identified by Heartfield, Price and Greene, Inc. during a cultural resources survey of the Knowlton Levee conducted at the request of the U.S. Army Corps of Engineers, Memphis District. Although this report (AMASDA #1965) is not currently on file at the Arkansas Archeological Survey (Marion Kunetka 1997 personal communication), information pertaining to the survey is included in the Arkansas Archeological Project Area Database.

According to the database entry for AMASDA #1965, Heartfield, Price and Greene, Inc. conducted pedestrian survey augmented by shovel testing of an area approximately 20.5 ac (8.3 ha) in size. This testing regime resulted in the identification of six archeological sites. Only one of these sites was assessed as potentially significant; however, no site numbers were assigned to any of the cultural resources identified. In addition, no management recommendations concerning additional testing were included in the database entry for AMASDA #1965.

A review of the architectural files at the Arkansas Historic Preservation Program identified two cultural resources (DE0073 and DE0074) within the immediate vicinity of the Knowlton Seepage Berm project area. A portion of the Laconia Circle Levee (DE0073) is included within the currently proposed project area. As was discussed above, the Laconia Circle Levee was recorded by Jim Merritt in 1979 and was reported to date from the early 1800s. Although the Arkansas Historic Preservation Program suggests that the resource possesses historic significance on a "state" level, the site has not been formally assessed.

The reported location of Kappa Indian Village (DE0074) was noted adjacent to the south and east sides of the Laconia Circle Levee (DE0073). As was mentioned above, the area (DE0074) was recorded by Jim Merritt in 1979 and was described as the northern most village of the Arkansas Indians. Although the Arkansas Historic Preservation Program Inventory Form suggests that the resource possesses historic significance on a "national" level, the site has not been formally assessed.

Blue Lake Relief Wells

No cultural resource surveys or previously recorded archeological sites were identified within the proposed Blue Lake Relief Wells project area. In addition, an examination of the historic architecture files at the Arkansas Historic Preservation Program failed to identify any standing structures or cemeteries within the currently proposed project area.

Louise Seepage Berm #2, #3, and #4

A majority of the currently proposed Louise Seepage Berm #2, #3, and #4 project area was subject to Phase I cultural resources survey by American Resources Group, Ltd. of Carbondale, Illinois, in 1979, at the request of the U.S. Army Corps of Engineers, Memphis District (Nixon et al. 1982). The only portion of the currently proposed project area not included in the Nixon et al. (1982) survey was that portion of Louise Seepage Berm #4 located in T 5 N, R 7 E, S 26. Pedestrian survey of the Louise Levee was conducted by Nixon et al. (1982) between Mile 158/00+00 and Mile 168/34+36. The survey identified 16 standing structure complexes (6-b-1 - 6-b-16), 11 archeological sites (3CT109, 3CT110, 3CT179 - 3CT182, and 3CT187 - 3CT191), and three loci (LH6, LH7, and LH12) that were not assigned official state site numbers. In addition, a single previously recorded site (3CT3) was reinvestigated. Of these, only Site 3CT3, which was described as a scatter of prehistoric materials dating from the late Mississippian Period, was assessed as potentially significant and additional testing was recommended. The remaining three loci, 11 sites, and 16 standing structure complexes were assessed as not significant; no additional testing was recommended. Of these cultural resources, only a portion of Site 3CT109 is located within the currently proposed Louise Seepage Berm #3 project area.

Site 3CT109 was described as a surface scatter of prehistoric materials. According to the Arkansas Archeological Survey Site Survey Form, the site dated from the Mississippian period; however, Nixon et al. (1982) suggested that Site 3CT109 represented a Middle Baytown period of occupation. Site 3CT109 was assessed as not significant and no additional testing was recommended.

Louise Seepage Berm #1

The entire 450 m (1476.4 ft) length of the currently proposed project area was subject to Phase I cultural resources inventory in 1979 by American Resources Group, Ltd. of Carbondale, Illinois (Nixon et al. 1982). The results of this survey have been presented above. None of the cultural resources identified by Nixon et al. (1982) are located within the currently proposed Louise Seepage Berm #1 project area.

The extreme northern portion of the currently proposed Louise Seepage Berm #1 project area was included in a Phase I cultural resources survey conducted by the Arkansas Archeological Survey in 1981 prior to proposed improvements to the city of West Memphis sewer system (Waddell 1981). The survey was completed at the request of Bond Consulting Engineers, Inc.of West Memphis, Arkansas. Pedestrian survey augmented by shovel testing and limited unit excavation resulted in the identification of Sites 3CT206 - 3CT210 and of one isolated find. None of the five sites or the isolated find were assessed as significant and no additional testing was recommended. None of cultural resources identified by Waddell (1981) are located within the currently proposed Louise Seepage Berm #1 project area.

Pecan Point Seepage Berm

No cultural resource surveys, previously recorded archeological sites, or cemeteries were identified within the proposed Pecan Point Seepage Berm. In addition, an examination of the historic architecture files at the Arkansas Historic Preservation Program failed to identify any standing structures within the proposed Pecan Point Seepage Berm.

Butler Seepage Berm

No cultural resource surveys or previously recorded archeological sites were identified within the currently proposed Butler Seepage Berm project area; however, a single historic resource was noted within the proposed Butler Seepage Berm #1 area. The Social Bend House Site (MS0095) was identified on the Nodena, Ark. - Tenn. 7.5' topographic quadrangle on file at the Arkansas Historic Preservation Program. The Social Bend House Site was recorded in 1971 by Gary Rounsavall. The date of construction was not noted but, according to the Arkansas Historic Preservation Survey Inventory Form, the house was no longer standing at the time of recordation. The site was not assessed and no recommendations concerning additional testing were reported.

Baders-Cotton Point Seepage Berm

An approximately 100 m (328.1 ft) long portion of the currently proposed project area located in Mississippi County, Arkansas was subject to Phase I cultural resources survey by American Resources Group, Ltd., of Carbondale, Illinois, during June, 1980 (Nixon et al. 1981). The survey was conducted at the request of the U.S. Army Corps of Engineers, Memphis District. Pedestrian survey of the proposed 30.3 km (18.8 mi) long project area resulted in the identification of four historic period sites (3MS384 - 3MS387), 15 standing structure complexes (5-b-1 - 5-b-4 and 5-b-6 - 5-b-16), and a cemetery (5-b-5) in Arkansas. None of these sites or standing structures was assessed as significant and no additional testing was recommended. Nixon et al. (1981) did recommend that Site 3MS384 (an historic period cemetery) be avoided during proposed construction. Neither sites 3MS384 - 3MS387 nor the 15 standing structure complexes identified by American Resources Group, Ltd. are located within the Arkansas portion of the proposed Baders-Cotton Point Seepage Berm. The remainder of the currently proposed project area is located in Missouri.

Tennessee

The Tennessee portion of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS) project area included two items. The information presented here is based on a background search of information currently on file at the Department of Environment and Conservation, Division of Archaeology and the Tennessee Historical Commission, Nashville, Tennessee.

Miston Seepage Berm

During 1979, American Resources Group, Inc. of Carbondale, Illinois, conducted a Phase I cultural resources survey of the entire length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Memphis District (McNerney and Nixon 1980; Nixon 1982a). In addition to the cultural resources survey, Fischer-Stein Associates of Carbondale, Illinois, also conducted an architectural resources survey of the entire length of the currently proposed project area during 1979 at the request of the U.S. Army Corps of Engineers (White 1980; Nixon 1982a). The archeological, architectural and historical components of the two reports (McNerney and Nixon 1980; White 1980) were combined into one final report by Nixon (1982a). The surveys consisted of the first 90.8 km (56.4 mi) long component of a six component contract. Pedestrian survey augmented by shovel testing of the 11.3 km (7 mi) long Miston Berm project area resulted

in the identification of two historic period sites (40DY48 and 40DY49) and a single prehistoric period site (40DY50). In addition, Nixon (1982a) reported that 10 standing structure complexes (1-f-1 - 1-f-10) also were identified. None of the sites or structures were assessed as significant and no additional testing was recommended. None of the sites or standing structures are located within the currently proposed Miston Seepage Berm project area.

Phillippy Seepage Berm

As was previously described in 1979, American Resources Group, Inc., conducted a Phase I cultural resources survey of the entire length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Memphis District (McNerney and Nixon 1980; Nixon 1982a). The results of this survey are described above. Pedestrian survey augmented by shovel testing failed to identify any archeological sites within the 3.5 km (2.2 mi) long Phillippy Seepage Berm project area; however, two standing structure complexes (1-b-1 and 1-b-2) were identified. Neither of these standing structure complexes were assessed as significant and no additional testing was recommended. Standing structure complexes 1-b-1 and 1-b-2 are not located within the currently proposed project area.

Kentucky

Only one project area is located within the Kentucky portion of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS) project area. The information presented here is based on a background search of information currently on file at the Office of State Archaeology, University of Kentucky, Lexington, Kentucky and Kentucky Heritage Commission, Frankfort, Kentucky.

Island No. 8 Relief Wells

During 1979, American Resources Group, Inc. of Carbondale, Illinois, conducted a Phase I cultural resources survey of the entire length of the currently proposed project area at the request of the U.S. Army Corps of Engineers, Memphis District (McNerney and Nixon 1980; Nixon 1982a). In addition to the cultural resources survey, Fischer-Stein Associates also of Carbondale, Illinois, conducted an architectural resources survey of the entire length of the currently proposed project area during 1979 at the request of the U.S. Army Corps of Engineers (White 1980; Nixon 1982a). The archeological, architectural and historical components of the two reports (McNerney and Nixon 1980; White 1980) were combined into one final report by Nixon (1982a). The surveys documented the first 90.8 km (56.4 mi) long component of a six component contract, totaling 349.2 km (217 mi) of levee (Nixon 1982a). Pedestrian survey augmented by shovel testing of the 26.2 km (16.3 mi) long Island No. 8 project area resulted in the identification of nine historic period sites (15FU28 - 15FU36) and one site (15FU27) which consisted of both prehistoric and historic period components. In addition, 18 standing structure complexes (1-a-1 - 1-a-18) also were identified by Nixon (1982a). None of these sites or standing structure complexes were assessed as significant; no additional testing was recommended. A total of three sites (15FU34 - 15FU36) and one standing structure (1-a-9) are located within the currently proposed Island No. 8 Relief Wells project area.

Site 15FU34 was located partially inside of the Island 8 Relief Well #7 project area. Site 15FU24 was described as a dense historic period artifact scatter dating from the nineteenth and twentieth century that was suggested to represent a former farm laborer's dwelling (McNerney and Nixon 1980; Nixon 1982a). The site was assessed as not significant and no additional testing was recommended.

Site 15FU35 was located partially inside of the Island 8 Relief Well #7 project area. Site 15FU36 was described as an historic period artifact scatter dating from the nineteenth and twentieth century. The authors suggested that the site represented a former farm laborer's dwelling (McNerney and Nixon 1980; Nixon 1982a). Site 15FU35 was assessed as not significant and no additional testing was recommended.

Site 15FU36 was located on the landward side of the levee between the Island 8 Relief Wells #6 and the Island 8 Relief Wells #7 and within the proposed project area. Site 15FU36 consisted of a garage size outbuilding structure with one side that formerly was utilized as a chicken coop, an outhouse structure, and an historic period materials scatter dating from the nineteenth - twentieth centuries (McNerney and Nixon 1980; Nixon 1982a). Although the presence of the outbuilding, privy and trees suggested the presence of a house, Nixon (1982a) reported that no evidence of a foundation was identified in the area. Site 15FU34 was assessed as not significant and no additional testing was recommended.

The Ottis Lewis Farmstead (1-a-9), later assigned state standing structure number FU22, appears to be located partially within the currently proposed project area between Island 8 Relief Wells #6 and Island 8 Relief Wells #7. The Ottis Lewis Farmstead was reported to consist of a house, a barn, a wash house, a garage, a privy, a granary, a mobile home, and three outbuildings (White 1980; Nixon 1982a). With the exception of one outbuilding, all of the structures on the farmstead date from the mid twentieth century. The remaining outbuilding dated from the early - mid twentieth century. The Ottis Lewis Farmstead (1-a-9) was assessed as not significant and no additional testing was recommended.

Missouri

This section presents the preliminary results of a literature and records review for the Missouri portion of the Memphis District segment of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS). The information presented here is based on a search of background information currently on file at the Division of Archaeology of the State Historic Preservation Office, Jefferson City, Missouri, and the Archaeological Survey of Missouri, Columbia, Missouri. The U.S. Army Corps of Engineers, Memphis District, portion of the SEIS includes nine items in Missouri.

<u>Baders-Cottonwood Point Seepage Berm</u>

During June, 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources inventory at the request of the U.S. Army Corps of Engineers, Memphis District (Nixon et al. 1981). The approximately 17.7 km (11 mi) long survey area was located in Pemiscot County, Missouri, between Levee Miles 35/35+00 - 46/50+00 and included the entire currently proposed Baders-Cottonwood Point Seepage Berm project area. Pedestrian survey of the proposed Baders-Cottonwood Point Berm Item by American Resources Group, Ltd. resulted in the identification of two historic period sites (23PM566 and 23PM567), a single historic cemetery (23PM565), and 26 standing structure complexes (5-a-1 to 5-a-26). None of these sites or standing structures was assessed as significant and no additional testing was recommended. Nixon et al. (1981) did recommend that Site 23PM565 (Taylor Cemetery) be avoided during proposed construction. All three of the sites identified by Nixon et al. (1981) are located within the currently proposed Baders-Cottonwood Seepage Berm project area, while only 20 of the standing structure complexes (5-a-1 to 5-a-7, 5-a-10 to 5-a-12, 5-a-15, 5-a-16, 5-a-18 to 5-a-24, and 5-a-26) were located within the proposed project area. These standing structure complexes were reported to range in date from the early - mid twentieth century; however, none was assessed as significant and no additional testing was recommended. No standing structure forms associated with these 20 standing structure complexes were identified at the Division of Archaeology of the State Historic Preservation Office, Jefferson City, Missouri.

Site 23PM565 was reported to be the remains of the Taylor Cemetery. Nixon et al (1981) reported that several grave markers remained at the site and suggested that Site 23PM565 dated from ca. 1890 - 1920. Although the significance of Site 23PM565 was not assessed, it was recommended that the site be avoided during proposed construction.

Site 23PM566 was described as a historic period materials scatter identified adjacent to the levee. It was suggested that Site 23PM566 represented the remains of ca. 1830 - recent homesite. The site was assessed as not significant and no additional testing was recommended.

Site 23PM567 also was described as an historic period materials scatter. The site was located directly between the currently proposed Baders-Cottonwood Point Seepage Berm and Borrow Pit #3. It was suggested that the site dated from 1850 - 1920 and may have represented the remains of a homestead. Site 23PM567 was assessed as not significant and no additional testing was recommended.

South Caruthersville Seepage Berm

During 1983, Heartfield, Price and Greene, Inc., of Monroe, Louisiana, conducted a Phase I cultural resources inventory in Pemiscot County, Missouri, between Mississippi River Levee Station 24/69+00 - 31/17+10 (Heartfield, Price and Greene, Inc. 1983). The approximately 11.3 km (7 mi) long survey area included an approximately 3.7 km (2.3 mi) long portion of the approximately 7.7 km (4.8 mi) long currently proposed South Caruthersville Seepage Berm. Pedestrian survey augmented by shovel testing resulted in the identification of six archeological sites (23PM569, 23PM570, NLU-83-69, NLU-83-80, NLU-83-83, and NLU-83-85) and 173 standing structures within the survey area; however, none of these cultural resources are located within the currently proposed South Caruthersville Seepage Berm project area.

During a review of state records, a single archeological site (23PM84) was noted within the northern portion of the currently proposed South Caruthersville Seepage Berm project area. Site 23PM84 was recorded by W. Stinson in 1978 and was described as a historic scatter of debris, including plastic and paper. This site was reported to be located on the levee bank approximately 2 m (6.6 ft) above waterline. No statements as to the significance of Site 23PM84 or recommendations concerning additional testing were made on the Archaeological Survey of Missouri site form.

Barnes Ridge Relief Wells

During 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources survey of approximately 106.2 km (66 mi) of proposed levee berm construction areas surrounding the New Madrid Floodway in New Madrid and Mississippi counties, Missouri (Nixon 1982b). The cultural resources survey, which was conducted at the request of the U.S. Army Corps of Engineers, Memphis District, included the entire currently proposed Barnes Ridge Relief Wells project area. Pedestrian survey resulted in the identification of 25 historic period sites (23MI552, 23MI562, 23MI563, 23MI567, 23MI569, 23MI570, 23MI573, 23MI579 - 23MI582, 23MI584, 23MI586 - 23MI588, 23MI592, 23MI594, 23NM526, 23NM529 - 23NM535), 34 prehistoric period sites (23MI1, 23MI29B, 23MI53, 23MI70, 23MI71, 23MI135, 23MI538, 23MI550, 23MI551, 23MI553 - 23MI556, 23MI558, 23MI560, 23MI561, 23MI564 - 23MI566, 23MI568, 23MI571, 23MI572, 23MI574, 23MI576 - 23MI578, 23MI583, 23MI585, 23MI589 - 23MI591, 23MI593, 23NM527, and 23NM528), and 272 architectural features. According to Nixon (1982b) none of the 272 architectural features or the 25 historic period archeological sites was assessed as significant and no additional testing was recommended; however, it was recommended that Site 23MI575 (Calhoun Cemetery) be avoided during proposed construction. A total of 12 prehistoric sites (23MI53, 23MI70, 23MI71, 23MI135, 23MI550, 23MI551, 23MI553, 23MI564, 23MI568, 23MI572, 23MI576, and 23MI577) were assessed as potentially significant; avoidance during construction or additional testing of these sites was recommended. In addition, Nixon (1982b) reported that Site 23MI1 had been listed previously on the National Register of Historic Places. It was recommended that Site 23MI1 be avoided during proposed construction.

A total of six archeological sites (23MI568, 23MI571 - 23MI574, and 23MI577) reported by Nixon (1982b) were located directly within the currently proposed Barnes Ridge Relief Wells project area. Site 23MI568 was described as a scatter of prehistoric ceramic sherds and lithics. In addition, a single historic ceramic sherd was recovered from the site. It was suggested that Site 23MI568 represented a Baytown period occupation as well as an undetermined historic period occupation. Site 23MI568 was assessed as potentially significant and avoidance of the site during construction was recommended; however, if avoidance was not possible additional testing was recommended.

Site 23MI571 was described as consisting of both prehistoric and historic period cultural materials. It was suggested that the site represented occupations dating to the Late Mississippian period of the late nineteenth - late twentieth centuries. Site 23MI571 was assessed as not significant and no additional testing was recommended.

Site 23MI572 was described as a scatter of prehistoric ceramic sherds and lithic materials dating from the Baytown period. The site was assessed as potentially significant and avoidance during construction was recommended; however, if avoidance was not possible, additional testing was recommended.

Site 23MI573 dated from ca. 1825 - recent historic period and was described as scatter of historic ceramic sherds, glass shards, 1 plastic button, and a plastic toothbrush handle. The site was assessed as not significant and no additional testing was recommended.

Site 23MI574 was described as a scatter of 1 prehistoric ceramic sherd, 1 lithic flake, and 1 possible scraper. It was suggested that the site represented a Baytown period of occupation. Site 23MI574 was assessed as not significant and no additional testing was recommended.

Site 23MI577 was described as a scatter of prehistoric ceramic sherds and lithic materials. The site was reported to represent Archaic and Baytown periods of occupation. Site 23MI577 was assessed as potentially significant and avoidance during proposed construction was recommended. If avoidance of the site was not possible, then additional testing of Site 23MI577 was recommended.

On July 17, 1980, the Missouri Highway and Transportation Department conducted a Phase I cultural resources survey within T 24N, R 16E, Sections 5, 6, 7, and 8, Mississippi County, Missouri, prior to the proposed replacement of the Route 102 bridge over the spillway ditch located adjacent to the New Madrid levee setback and the excavation of two borrow pits (Kross 1981). The size of the project area was not reported; however, it included a portion of the currently proposed Barnes Ridge Relief Wells project area. Pedestrian survey failed to identify any archeological sites, but a standing structure was noted. Kross (1981) assessed the structure as not significant. It is unknown whether this structure was located within the currently proposed project area. In addition, it was reported that Bridge Z-754 (which was located within the current project area) was assessed as not significant. No additional testing of the standing structure or Bridge Z-754 was recommenced.

Hubbard Lake Seepage Berm

During January, 1983, the U.S. Army Corps of Engineers, Memphis District conducted a cultural resources survey of two parcels (Inflow/Outflow Crevasse #1 and #2) totaling 307.2 ac (124.3 ha) in area prior to proposed levee degrading (Kekkonan and Martin 1983). The proposed Inflow/Outflow Crevasse #2 survey area was located within the currently proposed Hubbard Lake Seepage Berm project area in Section 6, T 22N, R 15E. Pedestrian survey augmented by shovel testing resulted in the identification of a single historic period locus (C#2#1). Locus C#2#1 was described as a surface and subsurface scatter of modern trash. The locus was assessed as not significant and no additional testing was recommended. Between December 1991 and March 1992, Environmental Research Center of Missouri, Inc., located in Jefferson City, Missouri,

conducted a Phase I cultural resources inventory of the Donaldson Point State Forest, New Madrid County, Missouri, at the request of the Missouri Department of Conservation, also located in Jefferson City, Missouri (Sturdevant 1992). The overall size of the area subjected to cultural resources survey was not reported; however, the entire currently proposed Hubbard Lake Seepage Berm project area was included within the Sturdevant (1992) survey area. Pedestrian survey resulted in the identification of previously recorded sites 23NM234 and 23NM506. In addition, two historic period surface scatters were identified; however, no information about these loci was reported by Sturdevant (1992). Site 23NM506 was located within the currently proposed Hubbard Lake Seepage Berm project area.

Site 23NM234 originally was recorded in 1964 by Sam Jones, who suggested that the site represented a Mississippian period of occupation. Sturdevant (1992) described Site 23NM234 as a surface scatter of lithic materials. No possible cultural affiliation was suggested by Sturdevant (1992); however, the site was assessed as potentially significant. Avoidance of Site 23NM234 during proposed construction projects was recommended.

Site 23NM506 originally was identified by an unspecified party at an unreported date. Other than locational data no other information concerning the site was provided on the Archaeological Survey of Missouri Survey Sheet. Sturdevant (1992) failed to provide any information concerning Site 23NM506 other than that the reported site area had been impacted by previous borrow activities. Sturdevant (1992) assessed Site 23NM506 as potentially significant and avoidance of the site during proposed construction projects was recommended.

Bayouville

During 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources survey of approximately 106.2 km (66 mi) of proposed levee berm construction areas surrounding the New Madrid Floodway in New Madrid and Mississippi counties, Missouri (Nixon 1982b). The cultural resources survey, which was conducted at the request of the U.S. Army Corps of Engineers, Memphis District, included the entire currently proposed Bayouville project area. The results of this survey are described above. A single site (23NM534) identified by Nixon (1982b) was located within the currently proposed Bayouville project area.

Site 23NM534 was described as an historic period materials scatter. It was suggested that the site represented a ca. 1855 - 1920 occupation. Site 23NM534 was assessed as not significant and no additional testing was recommended.

As was discussed above, during January, 1983, the U.S. Army Corps of Engineers, Memphis District conducted a cultural resources survey of two parcels (Inflow/Outflow Crevasse #1 and #2) totaling 307.2 ac (124.3 ha) in area prior to proposed levee degrading (Kekkonan and Martin 1983). The proposed Inflow/Outflow Crevasse #1 survey area was located within the currently proposed Bayouville project area in Sections 15, 22, and 23, T 23N, R 16E. Pedestrian survey failed to identify any cultural resources; no additional testing was recommended.

Above Dorena

During September of 1977, Richard Fischer and James Rudolph conducted a cultural resources survey of approximately 11.7 km (7.3 mi) of levee modification and improvement in Mississippi County, at the request of the U.S. Army Corps of Engineers, Memphis District (McNerney and Fischer 1978). The survey

included a right-of-way averaging 152.4 m (500 ft) in width, including the levee, between levee Miles 55/00 and 62/34+00. This survey encompassed the currently proposed Above Dorena Parcel 2 project area, specifically the Above Dorena Parcel 2 Seepage Berm #1 and Borrow Pit #1 project areas. Pedestrian survey failed to identify any archeological sites; however, an historic cemetery (Allen Cemetery) was identified to the north of levee mile 56/42+10. The cemetery was assessed as not significant. McNerney and Fischer (1978) reported that the U.S. Army Corps of Engineers, Memphis District were aware of the Allen Cemetery and planned to avoid it during proposed construction. As plotted by McNerney and Fischer (1978), the Allen Cemetery is located within the currently proposed Above Dorena project area.

During 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources survey of approximately 106.2 km (66 mi) of proposed levee berm construction areas surrounding the New Madrid Floodway in New Madrid and Mississippi counties, Missouri (Nixon 1982b). The cultural resources survey, which was conducted at the request of the U.S. Army Corps of Engineers, Memphis District, included the Parcel 1 and Parcel 3 portions of the currently proposed Above Dorena project area. The approximately (7.5 mi) long Parcel 2 portion of the currently proposed Above Dorena project area was not subjected to cultural resources survey by Nixon (1982b). The results of this survey have been presented above.

A total of six sites (23MI1, 23MI70, 23MI135, 23MI558, 23MI560, and 23MI587) reported by Nixon (1982b) were located directly within the currently proposed Above Dorena project area. Site 23MI1 (Crosno Fortified Village Archaeological Site) was located within Sections 25 and 26, T 25N, R 17E. The site, which was listed in the National Register of Historic Places in 1969, was described as a prehistoric mound and village area dating from the middle baytown - late Mississippian periods. According to the National Register of Historic Places Inventory - Nomination Form, Site 23MI1 originally consisted of four mounds, but only the largest remained at the time of its nomination to the Register. It also was reported that the remaining mound had been incorporated into the Mississippi River levee and that a barn was present on top of the mound. Nixon (1982b) recommended that Site 23MI1 be avoided during proposed construction.

Site 23MI70 was recorded by Ray Williams in 1967 and was located within the currently proposed Above Dorena Parcel 3 Seepage Berm #3 project area. The site was described by Williams as a small scatter of prehistoric ceramic sherds. Nixon (1982b) reinvestigated Site 23MI70 and described the site as consisting of a scatter of prehistoric ceramic sherds and lithics. In addition, a single historic ceramic sherd was recovered. It was suggested that Site 23MI70 represented a Baytown period or possible Mississippi period of occupation. The site was assessed as potentially significant; avoidance during construction or additional testing of Site 23MI70 was recommended.

Site 23MI135 was recorded at an unreported time by an unspecified party; however, the site was reinvestigated by Nixon (1982b) and described as a scatter of prehistoric ceramic sherds and lithics. In addition, three historic artifacts dating from an unspecified period were noted. It was suggested that Site 23MI135 represented Baytown and early - mid Mississippi periods of occupation and that it may have been associated with Site 23MI1. Site 23MI135 was assessed as potentially significant and avoidance during construction or additional testing was recommended.

Site 23MI558 was described as a scatter of lithic materials dating from an undetermined prehistoric period. In addition, a single historic stoneware sherd was recovered from the site. Site 23MI558 was assessed as not significant and no additional testing was recommended.

Site 23MI560 was described as a scatter of prehistoric and historic period ceramic sherds. The site was located within the currently proposed Above Dorena Parcel 3 Ditch to be Filled and Excavated project area. It was suggested that Site 23MI560 represented a prehistoric Baytown period of occupation as well as a ca. 1825 - 1960 historic occupation. The site was assessed as not significant; no additional testing was recommended.

Site 23MI587 was described as a historic period materials scatter dating from ca. 1820 - 1900+. It was suggested that the site may have represented the location of a homestead. Site 23MI587 was assessed as not significant and no additional testing was recommended.

Review of the archeological site files at the Archaeological Survey of Missouri identified one additional site (23MI597) that was located directly within the currently proposed Above Dorena project area, specifically the Above Dorena Parcel 2 Seepage Berm #1. Site 23MI597 was recorded by Heartfield, Price and Greene, Inc., in 1984 during a cultural resources inventory of Item #R929 (Parcel 2) Above Dorena, Missouri, for the U.S. Army Corps of Engineers, Memphis District. Site 23MI597 was described as a scatter of historic period materials located in a cultivated field. It was suggested that the site dated from the mid-twentieth century. Site 23MI597 was assessed as not significant. No statement concerning additional testing of the site was provided on the site data form; however, a statement on the form suggested that a cultural resources survey report detailing the above mentioned survey was produced by Heartfield, Price and Greene, Inc., in February, 1984. This report could not be located during the current literature and records review at the Division of Archaeology of the State Historic Preservation Office, Jefferson City, Missouri (Allen Tatman 1997; personal communication).

Samos Seepage Berm

During 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources survey of approximately 106.2 km (66 mi) of proposed levee berm construction areas surrounding the New Madrid Floodway in New Madrid and Mississippi counties, Missouri (Nixon 1982b). The cultural resources survey, which was conducted at the request of the U.S. Army Corps of Engineers, Memphis District, included the entire currently proposed Samos Seepage Berm project area. The results of this survey have been presented above. A single site (23MI562) identified by Nixon (1982b) was located within the currently proposed project area.

Site 23MI562 was located within the currently proposed Samos Seepage Berm #1 project area. The site was described as an historic period materials scatter dating from ca. 1855 -1920. Site 23MI562 was assessed as not significant and no additional testing was recommended.

On December 1 and 2, 1980, the U.S. Army Corps of Engineers, Memphis District, conducted a Phase I cultural resources inventory within Section 30, T 26N, R 17E, Mississippi County, Missouri, prior to proposed levee repair (Prescott 1980). This survey included approximately 0.7 km (0.4 mi) of the currently proposed Samos Seepage Berm project area. Pedestrian survey failed to identify any cultural resources within the proposed levee repair area; no additional testing was recommended.

During 1982, the U.S. Army Corps of Engineers, Memphis District, conducted a Phase I cultural resources inventory of a proposed borrow pit (Slide Repair Mile 9/10), located in Mississippi County, Missouri (Grosso 1982). The proposed borrow pit was located within a portion of the currently proposed Samos Seepage Berm project area in Section 25, T 26N, R 16E. Pedestrian survey identified Site 23MI596; however, it was reported that the site was located outside the proposed borrow pit area. Site 23MI596 was described as a prehistoric lithic materials scatter and it was suggested that the site represented an Archaic period of occupation. Site 23MI596 was not assessed and it was recommended that no excavating take place within 15.2 - 30.5 m (50 - 100 ft) of the recorded boundary of Site 23MI596. Site 23MI596 is not located within the currently proposed Samos Seepage Berm project area.

Between 1986 and 1987, Historic Preservation Associates of Fayetteville, Arkansas, conducted a Phase I cultural resources survey of the St. Johns Bayou Basin Project, located in portions of Scott, Mississippi, and New Madrid counties, Missouri, at the request of the U.S. Army Corps of Engineers, Memphis District (Klinger et al. 1988). This survey included the currently proposed Samos Seepage Berm project area.

Pedestrian survey augmented by shovel testing identified two sites (23MI601 and 23MI602) within the vicinity of the proposed Samos Seepage Berm project area. Both sites were described as historic period materials scatters dating from the early twentieth century. Neither Site 23MI601 nor Site 23MI602 was assessed as significant and no additional testing was recommended. These sites are not located directly within the currently proposed Samos Seepage Berm project area.

Commerce to Birds Point Levee Grade Raise

During December, 1979 and January, 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources inventory of 44.4 km (27.6 mi) of levees located in southeastern Missouri, at the request of the U.S. Army Corps of Engineers, Memphis District (Nixon 1980a). The area subjected to survey included the entire currently proposed Commerce to Birds Point Levee Grade Raise project area. Pedestrian survey augmented by shovel testing resulted in the identification of six prehistoric period sites (23CG53 and 23ST187 - 23ST191) and five historic period sites (23CG51, 23CG52, and 23ST184 - 23ST186). In addition, 24 architectural and structural features also were identified. Sites 23CG51 - 23CG53, 23ST184 - 23ST186, 23ST188, and 23ST190 were assessed as not significant and no additional testing was recommended. Of the remaining sites, only Site 23ST189 was assessed as significant and avoidance of the site during planned construction was recommended. Sites 23ST187 and 23ST191 were assessed as potentially significant; additional testing of both the sites was recommended. A total of 22 of the architectural and structural features noted by Nixon (1980a) were assessed as not significant and no additional testing was recommended. Nixon (1980a) reported that additional research was being conducted in order to assess the significance of the remaining two architectural resources (2-a-2 and 2-b-12).

A total of four sites (23ST186, 23ST187, 23ST189, and 23ST190) identified by Nixon (1980a) are located within the currently proposed Commerce to Birds Point Levee Grade Raise project area. Site 23ST186 was described by Nixon (1980a) as a surface scatter of historic period materials dating from the late nineteenth - early twentieth century. The site was assessed as not significant and no additional testing was recommended.

A site update form concerning additional testing at Site 23ST186 was completed by Prentice Thomas and Associates of Ft. Walton Beach, Florida, during August, 1997. They reported that pedestrian survey conducted in 1997 identified a surface scatter of late nineteenth - early twentieth century historic materials. Site 23ST186 was assessed as not significant; however, no recommendations concerning additional testing were provided on the site update form.

Site 23ST187 was described by Nixon (1980a) as scatter of prehistoric ceramic sherds and lithic materials dating from the Early Baytown and Mississippian periods. The site was assessed as potentially significant and additional testing was recommended. Prentice Thomas and Associates submitted a site update form for Site 23ST187 during August, 1997. Pedestrian survey conducted at Site 23ST187 identified prehistoric ceramic sherds and lithics. In addition, historic period materials dating from the mid- twentieth century also were noted at the site. Site 23ST1 was assessed as potentially significant; however, no recommendations concerning additional testing were provided on the site update form.

Site 23ST189 was described by Nixon (1980a) as a scatter of prehistoric cultural materials. In addition, 2 historic ceramic sherds were identified at the site. It was suggested that the site represented a Late Baytown and mid - late Mississippian periods of occupation. Site 23ST189 was assessed as significant and Nixon (1980a) recommended that the site be avoided during proposed construction.

During August, 1997, Prentice Thomas and Associates completed site update form for Site 23ST189. Pedestrian survey conducted by Prentice Thomas and Associates resulted in the collection of prehistoric and historic period cultural materials. No potential cultural affiliation was provided by Prentice Thomas and Associates; however, the site was assessed as potentially significant. No recommendations concerning additional testing of Site 23ST189 were reported on the site update form.

Site 23ST190 was described by Nixon (1980a) as a scatter of prehistoric ceramic sherds and lithic materials. In addition, a single historic gunflint reportedly was recovered from the site. It was suggested that Site 23ST190 represented a Middle - Late Baytown period of occupation. The site was assessed as not significant and no additional testing was recommended. Prentice Thomas and Associates completed a site update form for Site 23ST190 during August, 1997. Pedestrian survey of Site 23ST190 identified a scatter of prehistoric lithic materials and historic period artifacts. A potential cultural affiliation of the site was not indicated on the site update form. Site 23ST190 was assessed as not significant; however, no recommendations concerning additional testing were reported.

It should be noted that, while Prentice Thomas and Associates submitted site update forms for the sites discussed above (23ST186, 23ST187, 23ST189, and 23ST190) in August, 1997, a report detailing the cultural resources survey that led to the reinvestigation of these sites is not currently on file at the Division of Archaeology of the State Historic Preservation Office, Jefferson City, Missouri (Allen Tatman 1997; personal communication).

<u>Nash Relief Wells</u>

During December, 1979 and January, 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources inventory of 44.4 km (27.6 mi) of levees located in southeastern Missouri, at the request of the U.S. Army Corps of Engineers, Memphis District (Nixon 1980a). The area subjected to survey included the portions of the currently proposed Nash Relief Wells project area located in Section 36, T 30N, R 12E and Section 31, T 30N, R 13E. The results of this survey have been presented above. Of the 11 sites identified by Nixon (1980a), only one (Site 23CG53) is located within the currently proposed Nash Relief Wells project area.

Site 23CG53 was described a scatter of prehistoric lithic materials. In addition, a pre-1920 historic glass bottle shard was recovered from the site. It was suggested that Site 23CG53 represented an Early Baytown period of occupation. The site was assessed as not significant and no additional testing was recommended.

During December, 1995, Mid-Continental Research Associates, Inc., of Springdale, Arkansas, conducted a Phase I cultural resources inventory of Nash Relief Wells, Parcels 3, 4a, and 4b located in portions of Cape Girardeau and Scott counties, Missouri, at the request of the U.S. Army Corps of Engineers, Memphis District (Sierzchula 1996). The Parcels 4a and 4b survey area included the entire currently proposed Nash Relief Wells project area. Pedestrian survey augmented by shovel testing of the Nash Relief Wells Parcels 4a and 4b project area resulted in the identification of two prehistoric period sites (23CG214 and 23CG215) and one historic period site (23CG213). Sites 23CG214 and 23CG215 were assessed as potentially significant; it was recommended that the sites be avoided during proposed construction or additional testing be conducted. Site 23CG213 was assessed as not significant and no additional testing was recommended. Only one of these sites (23CG215) is located directly within the currently proposed project area.

A comparison of the recorded location of Site 23CG215 with the recorded location of Site 23CG53 (discussed above) revealed that these two sites are plotted in approximately the same place. Both sites were described as consisting of prehistoric lithic surface scatters. Sierzchula (1996) reported that a single Gary projectile point fragment also was recovered from Site 23CG215. It was suggested that the site represented a Late Archaic period of occupation. Site 23CG215 was assessed as potentially significant; avoidance of the site during proposed construction or additional testing was recommended.

Illinois

This section presents the preliminary results of a literature and records review conducted for the Illinois portion of the U.S. Army Corps of Engineers Supplement to the Final Environmental Impact Statement (SEIS). The information presented here is based on a background search of data currently on file at the Illinois State Historic Preservation Agency, Springfield, Illinois. The U.S. Army Corps of Engineers, Memphis District, Illinois portion of the SEIS project includes five areas in the state of Illinois.

<u>Above Cairo</u>

In 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, completed Phase I archeological, historical, and architectural surveys and inventories along a 29.5 km (18.3 mi) long project area located around the southernmost tip of Illinois at the request of the U.S. Army Corps of Engineers, Memphis District (Nixon 1980b). The Nixon (1980b) survey included two project areas (the Above Cairo Levee project area and the Cairo Levee project area). The Above Cairo Levee project area included the entire currently proposed Above Cairo project area and is discussed here. Pedestrian survey augmented by shovel testing of the 15.6 km (9.7 mi) long Above Cairo Levee project area resulted in the identification of one prehistoric period site (11AX229), three historic period sites (11AX226 - 11AX228) and 113 standing architectural features (3-b-1 - 3-b-113). None of the sites or architectural resources were assessed as significant and no additional testing was recommended.

Of the four sites (11AX226 - 11AX229) identified by Nixon (1980b), only Site 11AX228 is located within the currently proposed project area, specifically within Above Cairo Borrow Pit #3. It was suggested that Site 11AX228 represented the remains of a late 1800s - early 1900s residence; however, no evidence of architectural features was identified. The site was assessed as not significant; no additional testing was recommended.

<u>Cairo Floodwall Seepage Berms #1 and #2</u>

As was discussed previously, during 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources survey along a 29.5 km (18.3 mi) long project area located around the southernmost tip of Illinois at the request of the U.S. Army Corps of Engineers, Memphis District (Nixon 1980b). The Nixon (1980b) survey included two distinct project areas (the Above Cairo Levee project area and the Cairo Levee project area). The Cairo Levee project area included the currently proposed Cairo Floodwall Seepage Berms #1 and #2 project area and is discussed here. Pedestrian survey augmented by shovel testing of the 13.8 km (8.6 mi) long Cairo Levee project area failed to identify any archeological sites; however, a total of 100 architectural resources (3-a-1 - 3-a-100) were noted by Nixon (1980b). It was reported that portions of the Cairo Historic District (which had been listed previously in the National Register of Historic Places in 1979) and the Mound City Civil War Historic District (which previously had been determined potentially eligible for listing in the National Register of Historic Places) were located within the project area; however, neither of these historic districts are located within the currently proposed Cairo Floodwall Seepage Berms #1 and #2 project area.

Of the 100 architectural features identified by Nixon (1980b), only one (3-a-2) was assessed as potentially significant while three architectural features (3-a-92, 3-a-94, and 3-a-97) were included in the Cairo Historic District. The remaining architectural features were assessed as not significant. Except for architectural feature 3-a-82 (the Illinois Central Railroad Bridge), none of the architectural features reported on by Nixon (1980b) are located within the currently proposed Cairo Floodwall Seepage Berms #1 and #2 project areas.

The western terminus of the Illinois Central Railroad Bridge (3-a-82) is located within the proposed Cairo Floodwall Seepage Berm #1 project area. Nixon (1980b) reported that the bridge crossed the Ohio River at Mile 8/20+25 and represented a late nineteenth - mid twentieth century Parker through truss construction with Pratt deck approaches. The bridge was assessed as not significant and no additional testing was recommended.

Cairo to Mound City Slurry Trench Relief Wells

As was mentioned previously, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources survey in 1980 along a 29.5 km (18.3 mi) long project area located around the southernmost tip of Illinois at the request of the U.S. Army Corps of Engineers, Memphis District (Nixon 1980b). The currently proposed Cairo to Mound City Slurry Trench Relief Wells project area was included in the Nixon (1980b) project area. The results of this survey are described above. Neither of the two historic districts identified by American Resources Group, Ltd. are located within the currently proposed Cairo to Mound City Slurry Trench Relief Wells project area. None of the 100 architectural features reported on by Nixon (1980b) are located within the currently proposed Cairo to Mound City Slurry Trench Relief Wells project area.

Mound City Wave Wash Protection

As was previously mentioned, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources survey in 1980 along a 29.5 km (18.3 mi) long project area located around the southernmost tip of Illinois at the request of the U.S. Army Corps of Engineers, Memphis District (Nixon 1980b). The currently proposed Mound City Wave Wash Protection project area was included in the Nixon (1980b) project area. Pedestrian survey augmented by shovel testing of the 13.8 km (8.6 mi) long Cairo Levee project area failed to identify any archeological sites; however, a total of 100 architectural resources (3-a-1 - 3-a-100) were noted by Nixon (1980b). It was reported that portions of the Cairo Historic District (which had been listed previously on the National Register of Historic Places in 1979) and the Mound City Civil War Historic District (which previously had been determined to be potentially eligible for listing on the National Register of Historic Places) were located within the project area; however, only a portion of the potential Mound City Civil War Historic District is located within the currently proposed Mound City Wave Wash Protection project area.

Of the 100 architectural features identified by Nixon (1980b), only two (3-a-2 and 3-a-3) were assessed as potentially significant. These architectural features were reported by Nixon (1980b) to be the main focus of the Mound City Civil War Historic District; however, only architectural feature 3-a-3 (later assigned site number 11PU140), was located within the currently proposed project area. Nixon (1980b) reported that Structure 3-a-3 represented the remains of Civil War Era navel ship yard. The site will be reported on in more detail below during the discussion of Watson (1981) and Goodwin and Jones (1986).

A total of three architectural features (3-a-92, 3-a-94, and 3-a-97) identified by Nixon (1980b) were reported to be included in the Cairo Historic District. The remaining architectural features were assessed as not significant and no additional testing was recommended.

Between July and September of 1980, Wapora, Inc., of Cincinnati, Ohio conducted a Phase I cultural resources survey along 58.1 km (36.1 mi) of the Ohio River in Illinois and Kentucky between River Miles 938.9 - 975.0 at the request of the U.S. Army Corps of Engineers, Louisville District (Watson 1981). The currently proposed Mound City Wave Wash Protection project area is located within a portion of the Watson (1981) study area. Pedestrian survey resulted in the identification of 53 previously unrecorded sites (W-595-1 - W-595-18, W-595-20 - W-595-22, W-595-24 - W-595-51, and W-595-53 - W-595-56) in Illinois and Kentucky for which official state site numbers were not reported. In addition, three previously recorded sites (11PU140, 15McN11, and 15BA14) were relocated. A total of two (11PU140 and W-595-54 [later assigned official state site number 11PU217]) of the 15 sites identified in Illinois by Watson (1981) were located within the currently proposed Mound City Wave Wash Protection project area.

Site 11PU140 originally was recorded by Pulcher in 1973 and described as a Civil War Era shipyard. Watson (1981) reported that the site represented the remains of the Mound City Marine Ways that was constructed between 1857 - 1859 and was utilized during the Civil War to construct ironclad ships. It also was reported that the shipyard was in use until ca. 1935. Site 11PU140 was assessed as potentially significant. Management recommendations for the site included additional records review, informant interviews, photographic documentation of existing components, and mapping of the site.

Site 11PU217 was described as a surface scatter of historic period ceramic sherds identified in the vicinity of Mound City public landing. Watson (1981) reported that the site dated from the early - mid twentieth century. Site 11PU217 was assessed as not significant; no additional testing was recommended.
Previously unrecorded site PU-217 (Mound City Landing), consisted of early to mid-twentieth century artifacts. Becauce of the paucity of artifacts and low integrity of the site, however, no additional testing was recommended.

During July and August, 1985 and again during June, 1986, R. Christopher Goodwin & Associates, Inc., conducted a cultural resources survey and assessment of previously recorded Site 11PU140 at the request of the U.S. Army Corps of Engineers, Memphis District, prior to the proposed construction of a slurry trench through a portion of the site (Goodwin and Jones 1986). The southernmost portion of the currently proposed Mound City Wave Wash Protection project area is located within the Goodwin and Jones (1986) survey area. In addition to archival, historical, cartographic, and oral research into the history of the site, pedestrian survey augmented by the excavation of two auger test and two test profile cuts also was completed. Goodwin and Jones (1986) reported that three standing structures were identified at Site 11PU140. These structures dated from the mid-twentieth century and were assessed as not significant. In addition, eight cradleways, utilized to pull ships from the river, also were noted at Site 11PU140. A total of five backhoe trenches also were excavated at the site. Goodwin and Jones (1986) reported that deep subsurface testing provided evidence that portions of Site 11PU140 remained intact. The site was assessed as potentially significant. It was recommended that the U.S. Army Corps of Engineers, Memphis District consult with the Illinois State Historic Preservation Officer to determine the National Register eligibility of Site 11PU140. Goodwin and Jones (1986) also stated that, even though the site was assessed as potentially significant, no *in situ* cultural deposits were identified within the proposed slurry trench right-of-way. In addition, it was suggested that major portions of the Civil War Era occupations of Site 11PU140 were located riverward of the proposed project area and would not be adversely impacted by proposed slurry trench construction.

Above Mound City Slurry Trench

As was mentioned previously, during February and April, 1980, American Resources Group, Ltd. and Fischer-Stein Associates, both of Carbondale, Illinois, conducted a Phase I cultural resources survey of the levees surrounding the southernmost portion of the State of Illinois at the request of the U.S. Army Corps of

Engineers, Memphis District (Nixon 1980b). The Nixon (1980b) survey area included an approximately 0.8 km (0.5 mi) long section of the southern portion of the currently proposed Above Mound City Slurry Trench project area. Pedestrian survey augmented by shovel testing failed to identify any cultural resources within this portion of the survey area. Therefore, no cultural resources have been previously identified within this previously surveyed portion of the currently proposed Above Mound City Slurry Trench project area.

Conclusions

The literature and records review in progress on behalf of the U.S. Army Corps of Engineers, Vicksburg and Memphis District includes 114 project areas in seven states including: 37 Louisiana items, 41 Mississippi segments, 19 Arkansas components, two areas in Tennessee, one item in Kentucky, nine Missouri elements, and five sections in Illinois. A study corridor encompassing 2 km (1.2 mi) centered on each individual project item, in most cases artificial protection levees, was searched for evidence of cultural resources. Research focused on previously conducted cultural resources inventories in the vicinity of the project area, archeological sites and cemeteries located within the study area, and recorded standing structures and National Register of Historic Places properties situated within the project corridor.

The preliminary results of this record review have been presented above. While the draft report will include detailed descriptions of the collected materials and additional historical data, this preliminary report presented basic data regarding previously identified cultural resources located directly within the proposed project items only. Information regarding all previously recorded cultural resources positioned within the 2 km (1.2 mi) wide study area will be presented in the draft report.

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PERSONAL COMMUNICATION

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Mahady, Mike 1997

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New Orleans District

REPORT FOR CULTURAL RESOURCES STUDY SUPPORTING SUPPLEMENT I TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT, MISSISSIPPI RIVER MAINLINE LEVEE, NEW ORLEANS DISTRICT

July 1998

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PRELIMINARY REPORT FOR CULTURAL RESOURCES STUDY SUPPORTING SUPPLEMENT I TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT, MISSISSIPPI RIVER MAINLINE LEVEE, NEW ORLEANS DISTRICT

Introduction

A preliminary literature and records review was conducted for the New Orleans District portion of the SEIS. The information presented here is based on a background search of information currently on file at the Louisiana Department of Culture, Recreation and Tourism, Office of Cultural Development, Division of Archaeology, Baton Rouge, Louisiana.

Based on this preliminary investigation, additional work will be required to complete cultural resources compliance requirements in some cases. NOD recommendations to avoid adverse impacts on historic properties will be fully coordinated with the State Historic Preservation Officer and Advisory Council on Historic Preservation. All cultural resources requirements will be completed before construction.

Fifth Levee District Levee Enlargement

An approximately 1.5 km portion of the currently proposed 5.6 km long project area was subject to cultural resources survey and archival inventory by R. Christopher Goodwin & Associates, Inc., during April, 1992 (Hinks, Heinrich, Smith, and Athens 1993). Of the approximately 1.5 km long project area, approximately 0.5 km was subjected to pedestrian survey augmented by auger testing while 1 km was the subject of archival research only. No cultural resources were identified and no additional testing was recommended. Additional work will be required for cultural resources clearance of the remaining project area.

Baton Rouge Front Levee

The entire 0.3 km length of the currently proposed project area was subject to Phase I cultural resources inventory in 1983 by the National Park Service, Denver Service Center (Shafer et al. 1984). Pedestrian survey was conducted by Shafer et al. between RM 231 and RM 228-L. The survey identified 11 standing structures and two previously recorded landing sites (Florida Street Dock and North Street Landing). None of these structures or sites was located within the currently proposed project area and none was assessed as significant. No additional testing was recommended.

During September and October 1992, R. Christopher Goodwin & Associates, Inc., conducted Phase I/II cultural resources survey and testing between RM 230 - RM 227-L (Hinks, Heinrich, Draughon, Jr., Cohen, and Athens 1993). This survey and testing program included the project area. A total of five historic sites (16EBR58, 16EBR95, 16EBR96, 16EBR98, and 16EBR99) were identified and tested. Of these sites, one (Site 16EBR99) is located within the southern portion of the current project area. Hinks, Heinrich, Draughon, Jr., et al. (1993) reported that none of the five sites was assessed as significant and no additional testing was recommended.

A single cultural resources survey has been conducted in the area of the currently proposed 0.3 ha borrow pit associated with the proposed Baton Rouge Front Levee. During October, 1976, J. Richard Shenkel conducted a pedestrian survey along the left descending bank of the Mississippi River from RM 218 - RM 213 (Shenkel 1976). A total of three sites (16EBR40, 16IB126, and 16IB127) were identified; however, none of these sites is located within the current borrow pit project area. Shenkel (1976) did not assess the sites and no recommendations concerning additional testing were reported.

Reveille to Point Pleasant

Prior to February 9, 1979, Coastal Environments, Inc., conducted a Phase I cultural resources inventory of the 1.3 ha borrow pit associated with the currently proposed Reveille to Point Pleasant project area (Gagliano et al. 1979). Survey identified several historic artifacts and 1 prehistoric ceramic sherd eroding from the cutbank. Gagliano et al. (1979) suggested that these materials had been disturbed and redeposited by prior levee construction. No official state site number was assigned and the locus was assessed as not significant. No additional testing was recommended.

During November, 1982, the National Park Service, Denver Service Center conducted a Phase I cultural resources survey of a 6.3 km long portion of the currently proposed 9.2 km long project area (Stuart and Greene 1983). Stuart and Greene reported that pedestrian survey from RM 204.9 - RM 201 failed to identify any cultural resources. No additional testing was recommended; it was suggested that deeply buried cultural deposits may have been present in the area.

Alhambra to Hohen-Solms

During August and September, 1985, R. Christopher Goodwin & Associates, Inc., conducted a Phase I cultural resources survey which included an approximately 0.8 km long portion of the project area (Goodwin et al. 1987). A total of five historic period sites (16IV147 - 16IV151) were identified. All of these sites are located within the project area. Of these, sites 16IV148, 16IV150, and 16IV151 were assessed as not significant and no additional testing was recommended. The remaining two sites (16IV147 and 16IV149) were assessed as potentially significant; additional testing of these sites was recommended.

During 1987, R. Christopher Goodwin & Associates, Inc., conducted Phase II evaluatory testing at sites 16IV147 and 16IV149 (Goodwin et al. 1988). Both sites were found to be disturbed by prior levee construction and neither was assessed as significant. No additional testing of sites 16IV147 and 16IV149 was recommended.

Hohen-Solms to Modeste

During July, 1992, R. Christopher Goodwin & Associates, Inc. conducted a Phase I cultural resources inventory of the proposed Smoke Bend Revetment extension (Hinks et al. 1994). This inventory encompassed an approximately 0.2 km long portion of the currently proposed 8.2 km long project area. Pedestrian survey augmented by shovel and auger testing resulted in the collection of 1 screw-lid bottle. No site number was assigned and the no additional testing was recommended.

Carville to Marchand

Prior to January, 1982, Iroquois Research Institute conducted a Phase I cultural resources survey of an approximately 1.1 km long portion of the Marchand Revetment in the vicinity of RM 181-L (Hartley et al. 1982), near the southern portion of the project area. Hartley et al. (1982) reported that no cultural resources were identified within the Marchand Revetment survey area; no additional testing was recommended.

During July and August, 1984, R. Christopher Goodwin & Associates, Inc., conducted a Phase I cultural resources survey of five Mississippi River revetment items two of which included portions of the currently proposed Carville to Marchand project area (Goodwin et al. 1985). An approximately 6.1 km long portion of the current 12.7 km long project area was subject to cultural resources inventory. Goodwin et al. (1985) identified a total of three new historic sites (16IV143 - 16IV145). In addition, two features associated with previously recorded Site 16AN26, Ashland-

Belle Helene Plantation were recorded. Sites 16IV143 - 16IV145 were assessed as not significant and no additional testing was recommended. The features associated with Site 16AN26 were described as a brick scatter and the brick foundation of a warehouse located at Ashland-Belle Helene Plantation Landing. Additional testing of these features was recommended.

During January, 1989, R. Christopher Goodwin & Associates, Inc., conducted Phase II evaluatory testing of three features located on the batture of the Mississippi River in the vicinity of Site 16AN26 (Goodwin et al. 1989). These three features consisted of the remains of a warehouse, a brick scatter, and an old levee. Of these features, two had been assigned site numbers 16AN37 and 16AN38. It was determined later that these sites were part of previously recorded Site 16AN26. None of the three features associated with Site 16AN26 was assessed as significant and no additional testing was recommended.

Carrollton Levee Enlargement

On January 19, 1977, J. Richard Shenkel conducted a Phase I cultural resources survey of the proposed Nashville Avenue to Napoleon Avenue Floodwall (Shenkel 1977). This survey included an approximately 100 m long portion of the current 5 km long project area in the vicinity of Nashville Avenue. Shenkel (1977) reported that the proposed floodwall would not impact any significant sites or structures. No additional testing was recommended.

During June, 1992, R. Christopher Goodwin & Associates, Inc., conducted archival research and a Phase I cultural resources survey from RM 105.7 - RM 101.7-L (Hinks, Heinrich, Draughon, Jr., Smith, Cohen, and Athens 1993). This survey included an approximately 3.7 km long portion of the project area. Only archival research was conducted by Hinks, Heinrich, Draughon, Jr., Smith, Cohen, and Athens (1993) on the portion of batture within the current project area; no archeological testing was conducted. It was reported that in the areas subject to Phase I cultural resources survey, no non-modern cultural resources were identified. No additional testing of these

areas was recommended.

On September 5, 1979, the U.S. Army Corps of Engineers, New Orleans District, completed a cultural resources inventory which included the area of the currently proposed 1.4 ha borrow pit associated with the proposed Carrollton Levee Enlargement (Rader 1980). Rader reported that a number of historic artifacts were noted outside the proposed project area. No site number was reported and no assessment of these materials was made. No cultural material was identified within the project right-of-way; however, Rader (1980) reported that archeological monitoring would be conducted during construction in the vicinity of previously recorded Fort St. Leon (no site number reported) and in the area adjacent to the historic material scatters which were noted outside of the proposed right-of-way.

Between October and December 1988, the Museum of Geoscience at Louisiana State University, conducted a cultural resources survey in the vicinity of the proposed Carrollton Levee Enlargement borrow pit (Franks and Yakubik 1994). Survey within the proposed Twelve Mile Point Revetment Item identified four historic period sites (16OR119 - 16OR122) and one locus (Twelve Mile Revetment Locale No. 5). None of these sites or the locus was assessed as significant and no additional testing was recommended.

Jefferson Heights

In June, 1992, R. Christopher Goodwin & Associates, Inc., conducted background research for the project area (Hinks, Heinrich, Draughon, Jr., Smith, Cohen, and Athens 1993). Archival research suggested that most archeological deposits within the project area would have been damaged or destroyed by prior levee and railroad construction. No non-modern cultural resources were identified. No additional investigation of these areas was recommended.

Gap Closures, West and East Bank

Cultural resource investigations will be required at a number of the small gap closure areas before construction.

New Orleans District Floodwall

R. Christopher Goodwin & Associates, Inc., completed archival research covering the project area. Archival research suggested that most archeological deposits within the project area would have been damaged or destroyed by prior levee and railroad construction.

Lower Venice 2nd Lift

Between February and March, 1979, the Anthropology Department of Tulane University conducted a Phase I cultural resources survey of portions of the west bank of the Mississippi River that were included in the East Bank Barrier Levee Plan of the New Orleans to Venice Hurricane Protection Levee system (Davis et al. 1981). This survey encompassed the project area. Davis et al. (1981) reported that no cultural resources were identified. Because no archeological sites were identified within the vicinity of the currently proposed project area, no recommendations concerning additional testing of this area were reported.

Prior to March, 1983, the National Park Service, Denver Service Center, conducted a Phase I cultural resources survey which included the project area (Stuart and Greene 1983b). Pedestrian survey failed to identify any cultural resources. No additional testing was recommended.

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APPENDIX 16
RECREATION/ESTHETICS

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 16
RECREATION/ESTHETICS

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MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 16
RECREATION/ESTHETICS

INTRODUCTION

1. This appendix addresses the recreational and esthetic aspects of the Mississippi River Mainline levees and seepage control features as they relate to alternative plans described in the Supplemental Environmental Impact Statement. The project area includes all lands and water between the Mississippi River levees, including 3,000 feet landside, beginning at Cape Girardeau, Missouri, and extending downstream to Head of Passes, Louisiana (see Project Report). There are approximately 980 river miles within the study boundaries and approximately 2,100,000 acres of land and 500,000 acres of water. Table 16-1 displays a summary of land use conditions within the study area.

2. Natural resource based recreational activities and associated esthetics represent a significant portion of recreation opportunities in the United States. In 1991, surveys conducted for the U.S. Fish and Wildlife Service (FWS) indicated that half of the people in the United States 16 years old or older enjoyed some type of wildlife-related recreation. Project area lands are an integral part of the natural resource base within the lower Mississippi Valley. Consumptive recreation uses within the project area are, principally, big game hunting (deer and turkey), small game hunting (squirrel, rabbit, raccoon, dove, etc.), waterfowl hunting, and sport fishing. Nonconsumptive recreation uses include wildlife photography, wildlife observation, feeding, nature study, bird watching, etc.

TABLE 16-1
PROJECT AREA LAND USE ACREAGE

Land Use	Nonwetland	Wetland	Total
Forested	385,456	636,254	1,021,710
Cropland	537,704	231,556	769,260
Urban/Industrial	71,570	4,594	76,164
Scrub/Shrub	23,939	43,440	67,379
Tree Plantations	27,887	22,584	50,471
Sandbar	3,790	45,600 a/	49,390
Pasture	22,854	19,536	42,390
Levee	26,990		26,990

TABLE 16-1 (Cont)

Land Use	Nonwetland	Wetland	Total
Herbaceous	3,469	11,043	14,512
Marsh		5,925	5,925
Bare Soil	1,742	1,825	3,567
Subtotal	1,105,401	1,022,357	2,127,758
Open Water			518,086
Total			2,645,844

a/ Jurisdictional (regulated) waters of the United States, but may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

SECTION 1 - RECREATION

3. An array of recreational resources is available in the Mississippi River corridor. These resources include more than 250 state-managed areas, including parks, natural areas, historic sites, fish and wildlife areas, recreation areas, scenic areas, and trails. More than 3 million visitors a year take advantage of these state resources. The National Park Service and FWS administer Federally owned recreational resources within the project area. The 15 areas managed by the National Park Service and the 21 refuges managed by FWS together receive more than 9 million visits each year.

4. The seven river states directly affected by the proposed project share several common recreational needs and are seeking to meet those needs. Primarily, these states foresee the need for greater opportunities close to home, more trail-oriented opportunities, and more opportunities for driving for pleasure and greater access to hunting and fishing resources.

5. Throughout the project area, recreational boating and fishing opportunities abound. Each year more than 6 million people participate in boating, the single most popular activity. There are 59 developed boat-launch access points into the Mississippi River along the length of the project (Table 16-2). Over half of the boat-launch access points are located within the upper portion of the project area. Water within the project area provides both a valuable recreational fishery and commercial fishery. These waters, which total approximately 500,000 acres, can be divided into three basic categories: Mississippi River waters, oxbow lake cutoffs, and borrow area. Mississippi River waters and oxbow lake cutoffs total approximately 98 percent of the fishery habitat in the project area and offer numerous opportunities for recreational and commercial fishing. While comprising only about 2 percent of fishery habitat within the project area, borrow areas represent a valuable fishery resource. However, the potential for recreational and commercial fishing opportunities is limited due to private ownership of the borrow areas.

TABLE 16-2
MISSISSIPPI RIVER ACCESS SITES

Location	River Mile	Designation
Memphis District		
Cache-Cairo	979.0-R	Public
Wickliffe	952.0-L	Public
Pritchard	947.5-R	Public
Island 1	944.5-L	Public
Columbus	937.0-L	Public
Dorena	924.6-R	Public
Hickman Harbor	921.5-L	Public
Chute of Island 8	911.0-L	Public
Slough Landing Neck	899.0-R	Public
New Madrid Front	888.6-R	Public
New Madrid Bend	888.0-R	Public
Merriwether-Cher	871.0-L	Public
Fritz Landing	856.0-L	Public
Caruthersville	846.0-r	Public
Linwood Bend	839.5-L	Public
Obion-Tamm	818.0-L	Public
Barfield	810.0-R	Public
Ashport-Keyes	795.6-L	Public
Bullerton	783.5-R	Public
Randolph	771.0-L	Public
Richardson Landing	768.0-L	Public
Island 35	777.0-R	Public
Shelby Forest	752.5-L	Public
Mud Island	738.5-L	Public
Ensley	Tenn Chute	Public
McKellar Lake	Tenn Chute	Private

TABLE 16-2 (Cont)

Location	River Mile	Designation
Norfolk Starr	711.0-L	Public
Peters	693.0-R	Public
Tunica Lake	677.5-L	Private
Helena Harbor	663.0-R	Public
Helena Cast Field	661.0-L	Public
Friars Point	654.0-L	Public
Island 63 Chute	637.0-L	Public
Sunflower Lake	624.5-L	Private
Mellwood	625.8-R	Private
Terrene Landing	592.0-L	Public
Rosedale Harbor	584.5-L	Private
Vicksburg District		
Huntington, MS	556.8-L	Private
Mayersville, MS	496.2-L	Public
Fitler, MS	478.6-L	Private
Cottonwood, MS	472.3-L	Private
Goodrich, LA	468.0-R	Public
Milleken Bend, LA	457.0-R	Public
Grand Gulf, MS	407.5-L	Private
Grand Gulf, MS	405.5-L	Private
St. Catherine, LA	351.0-R	Private
St. Catherine, LA	349.0-R	Private
Glasscock, LA	340.0-R	Private
Natchez, MS	363.5-L	Public
LeTourneau, MS	426.0-L	Public

TABLE 16-2 (Cont)

Location	River Mile	Designation
New Orleans District		
Old River	310-R	Public
Port Allen	227-R	Public
Plaquemine	222-R	Public
Point a la Hache	50-R	Public
Port Sulphur	39-R	Public
Empire	30-R	Public
Buras	25-R	Public
Ft. Jackson	20-R	Public
Venice	11-R	Public

6. Forested areas within the project area boundaries total in excess of 1,000,000 acres, predominantly bottom-land hardwoods. These public and private forested areas provide numerous opportunities for hunting, hiking, photography, bird watching, and other related activities. In addition, these forested lands in association with watered acres and cropland (i.e., corn, rice, and soybeans) provide valuable habitat for waterfowl.

7. In urban areas like New Orleans and Memphis, project lands provide walking and biking trails as an integral part of the recreation development along the river. Within the lands between the levees, numerous timber companies have land leased to hunting clubs. Also, state wildlife management lands are available to the public. Both fishing and hunting activities occur within these club lands and managed lands.

PROBABLE IMPACTS

8. Project construction requirements would result in land use changes, the most important of which would be the loss of forested areas and associated wildlife-related recreational value. Land use requirements for alternative plans are displayed in Table 16-3. However, adverse project impacts would be compensated by reforestation of frequently flooded agricultural lands. Plan 4 (recommended plan) would require reforestation of 5,863 acres.

TABLE 16-3
ESTIMATED LAND USE REQUIREMENTS RESULTING FROM CONSTRUCTION

Land Use Classification	Nonwetland (Acre)	Wetland (Acre)	Total (Acre)
	Alternative Plan 4	Alternative Plan 4	Alternative Plan 4
Memphis District			
Cropland	2,151	1,109	3,260
Forest	313	201	513
Levee	338	50	388
Open Water	12	22	34
Pasture/Old Field	44	0	44
Scrub Shrub	41	44	85
Urban	72	2	74
Total Memphis District			4,399
Vicksburg District			
Cropland	4,462	2,281	6,743
Forest	1,769	2,543	4,312

TABLE 16-3 (Cont)

Land Use Classification	Nonwetland (Acre)	Wetland (Acre)	Total (Acre)
	Alternative Plan 4	Alternative Plan 4	Alternative Plan 4
Herbaceous	95	165	260
Levee	273	15	288
Marsh	4	21	25
Open Water	62	924	986
Pasture/Old Field	332	312	644
Scrub Shrub	123	201	324
Tree Plantation	585	519	1,104
Urban	101	45	146
Outside Project Area	650	2	652
Total Vicksburg District			15,484
New Orleans District			
Cropland			
Forest		17	17
Herbaceous			
Levee			
Marsh			
Open Water			
Pasture/Old Field			
Scrub Shrub			
Tree Plantation			
Urban			
Total New Orleans District			17

9. Although public access would be limited, the project (Plan 4) would create 6,727 acres of fishery habitat through creation of borrow areas. Open areas will be reforested which will provide additional wildlife habitat. Some of the proposed borrow areas would be developed to create wetlands. These borrow areas would provide fishing habitat as well as scenic qualities. Waterfowl habitat would be created by installation of control structures for impounding water at some of these borrow areas. This could also foster recreational hunting. Proposed levee berms will also provide feeding habitat for wildlife.

CONCLUSION

10. While some fishery and wildlife habitat would be lost due to construction, it would be compensated for by the reforestation of 5,863 acres of frequently flooded agricultural lands. Also, the avoid-and-minimize plan allows for creation of additional habitats. The proposed borrow areas, water control structures, berms, and reforestations will create more recreation opportunities. The recommended plan would offset losses in recreational opportunities and contribute long-term benefits to the recreational resource base for the project area.

SECTION 2 - ESTHETICS

11. Esthetics may be considered as the appreciation of things of beauty. It is obviously an intensely personal and individual reaction, and what is esthetically pleasing to one person may not be to another. While a nature lover may prefer the raw wilderness, a farmer might appreciate the view of a field or ripening crops, and an engineer might be ecstatic over the graceful arches of a river bridge.

12. The Mississippi River, the largest river in the United States, offers a wide range of conditions esthetically attractive to people of varied tastes. The river is the most visually outstanding aspect of the project area landscape. Large bodies of water serve as an important element of visual composition because of their horizontal extent, color, and texture. The Mississippi River's sinuosity provides the additional visual characteristic of surprise. Inactive parts of the river, such as oxbows, fulfill a similar role. The natural and cultural land uses within the project area complement the river by their contrasting geometry, color, and texture, or are esthetically significant in their own right, as with the bottom-land hardwood forests. The relatively natural land uses, such as bottom-land hardwood forests, also provide habitat for many species of wildlife which can be considered esthetically significant components of the landscape.

13. Some of the most impressive scenery along the Mississippi River is from Reelfoot Lake to Memphis. Bluffs begin where the Obion and Forked Deer Rivers meet in Tennessee and provide the eastern boundary from there to Memphis. Proceeding south, there are Petit Gulf Hills, Ellis Cliffs, Tunica Bluff, Balls Bluff, and Mobile Ridge. Bluffs exist on the east side of the river from Vicksburg to Baton Rouge. There are beautiful overlooks and cliffs ending with Scott Bluffs at Southern University in Baton Rouge.

14. The project area contains many manmade features which either contribute to or detract from the esthetic quality of the project area. The river is constrained on the west bank by levees for almost the entire distance from Cairo to the Gulf. The east bank has considerably fewer miles of levee. The east bank levee in the Reelfoot Lake area extends from Hickman, Kentucky, southward to the Obion River. Almost all of the east bank is leveed from Memphis to Vicksburg, and no Mississippi River and Tributaries levees from Vicksburg to Baton Rouge. Below Baton

Rouge, approximately 90 percent of the east bank of the river is leveed. Other manmade features along the river include revetments constructed on both banks to protect the river channel. From Cairo to the Old River Control Structure, dikes have been built into the river, most several hundred feet long, but some as long as 1 mile. Almost all these dikes are under water at midbank stage; however, many are not only visible at lower river stages, but have greatly influenced the development of sand islands and bars as a result of the still water areas created by the dikes. Below the Old River Control Structure, dike construction has been limited.

15. Other major manmade features are the river crossings for roadways, railroads, and overhead utilities. These are landmarks along their river stretches, and can be either esthetically pleasing, or from some points of view, detrimental. The project area is relatively poor in architecturally outstanding manmade structures which can be considered esthetically pleasing, since it is used primarily for flood control, protection of adjacent areas, and navigation. The manmade features which do exist in the project area are generally of a utilitarian nature.

16. Although the river is vast, it is nearly featureless, and the observer often cannot get a true sense of its dimensions. A tow and barge provide a measure of scale for the scene and a reference point for the observer. Where wooded land has been cleared, the clearings provide edge definition of the natural wooded areas, and may serve to break up the visual monotony of continuous stretches of nearly identical woodlands. There is, of course, some point at which the presence of manmade elements can overwhelm the natural landscape and produce a system which some observers may find esthetically distressing, such as the industrialized corridor from Baton Rouge to New Orleans.

17. The levees provide visual access to the project area and adjoining lands where visibility is limited by the nearly level terrain. Bridges perform a similar function for the river and batture. In addition, bridges and large flood control structures may have an esthetic value to some observers as engineering works.

18. Other manmade features which contribute to the esthetic experience of the project area are archeological and historical sites. Although not always visually impressive in themselves, once understood, these places can provide an appreciation of the past, thus imbuing the physical scene with cultural ambience. Thus, while not a physically dominating feature of the landscape, historical and archeological sites aid the observer in his perception of the project area by enhancing the likelihood of using imagination to view the scene as it must have seemed to prehistoric and historical people who participated in the development of the study area.

19. Current land use within the study area consists of the following lands: cropland, forest, herbaceous, levee, marsh, open water, pasture/old field, scrub shrub, tree plantation, and urban (Table 16-1). Approximate total acreage within the study area is 2,645,844. With the project, an estimated 19,900 acres of land would be subjected to minor visual impacts.

20. To help minimize the impact to esthetics of the project, some reforestation of bottom-land hardwoods will be provided. Also, borrow areas will be designed and constructed in a way as to blend them into the surrounding area; thus, minimizing any visual impacts.

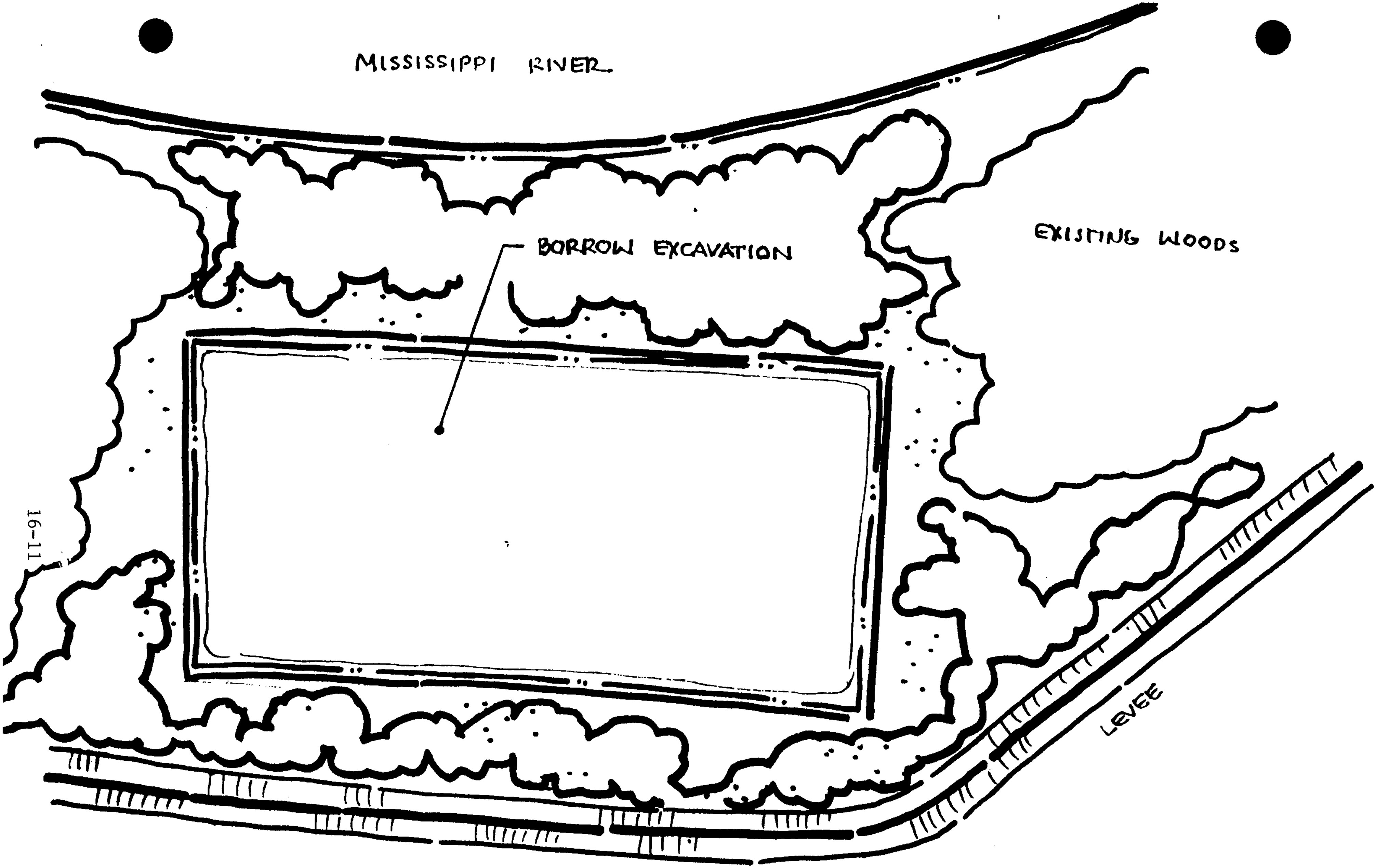
21. This project involves raising levees along portions of the Mississippi River. As a result of this work, borrow areas would be developed to supply fill material. Previously, traditional borrow areas were excavated in a rectangular shape with no esthetic concerns (Figure 16-1). Currently, maintaining the esthetic and habitat quality along the river is a high priority. To achieve this, the borrow areas would be designed to be a positive environmental feature of this work. Three types of borrow areas are proposed. Type A is 1 to 10 acres in size, Type B is 10 to 30 acres in size, and Type C is over 30 acres in size.

22. In most cases, Type A borrow area would be located in woodlands (Figure 16-2). Type B borrow areas would consist of an irregular-shaped shoreline with hardwood trees and other natural vegetative plantings. This type borrow area would be suitable for recreational fishing. In addition, peninsulas with loafing sites would be incorporated (Figure 16-3). Type C borrow area would consist of an irregular-shaped shoreline with hardwood trees and other natural vegetative plantings. These areas would have islands, peninsulas, loafing sites, and native grasses. This would be good habitat for wildlife (Figure 16-4).

23. All three types of borrow areas can be used for deep or shallow pits as well as landside or riverside pits. Visually, these borrow areas would be scenic and have good wildlife and fishery habitat. Specific design guidelines for these borrow areas are found in "Environmental Design Considerations for Main Stem Levee Borrow Areas Along the Lower Mississippi River, Lower Mississippi River Environmental Program, Report 4, April 1986." This report was prepared by the U.S. Army Corps of Engineers, Mississippi River Commission. Design of the borrow areas would be in accordance with this guidance, to the extent practical.

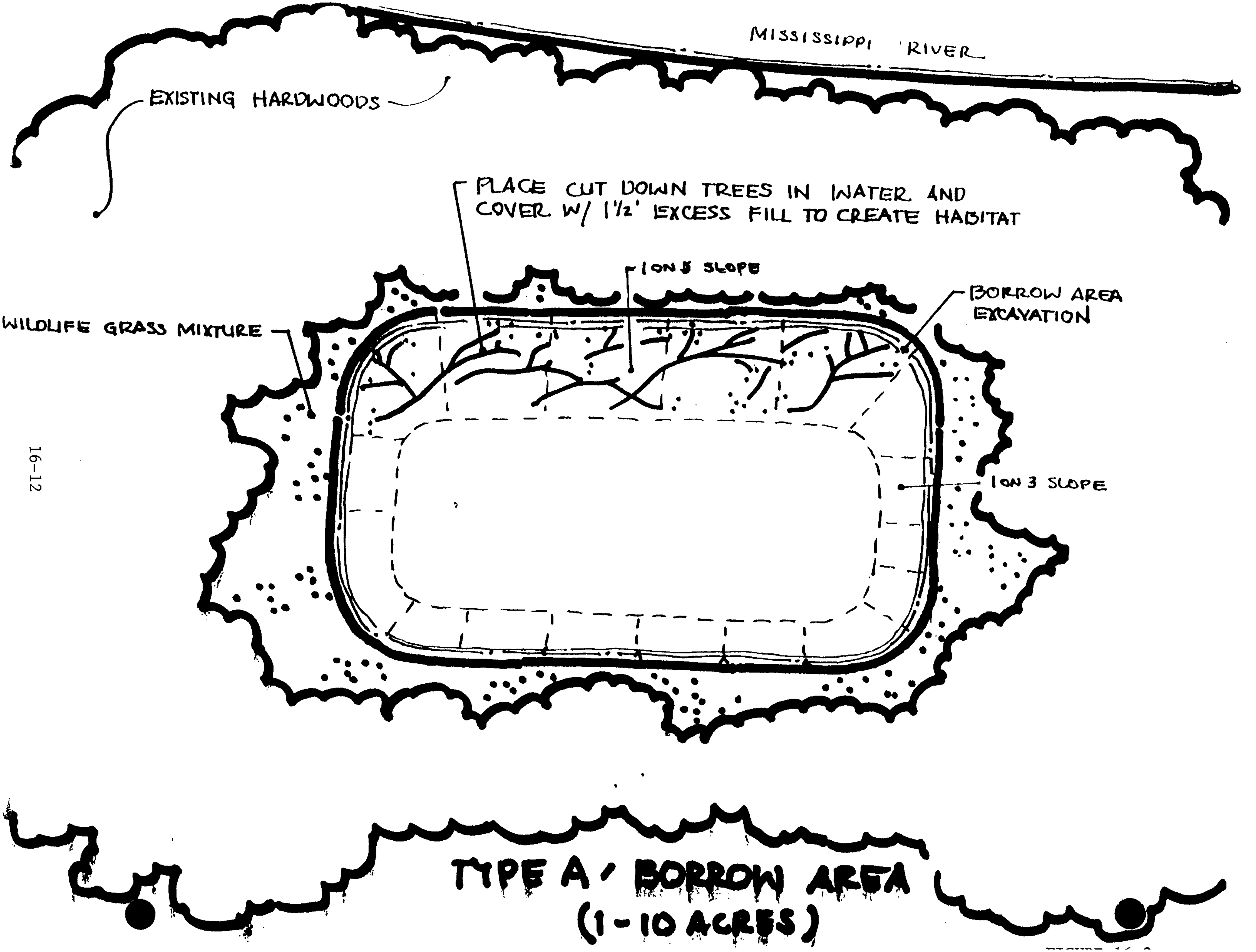
24. In addition, some seepage berms would be constructed on the levee's landside in sections along the project. These berms would be planted with grasses that would be suitable for wildlife forage. No trees would be planted on seepage berms in order to maintain their structural integrity.

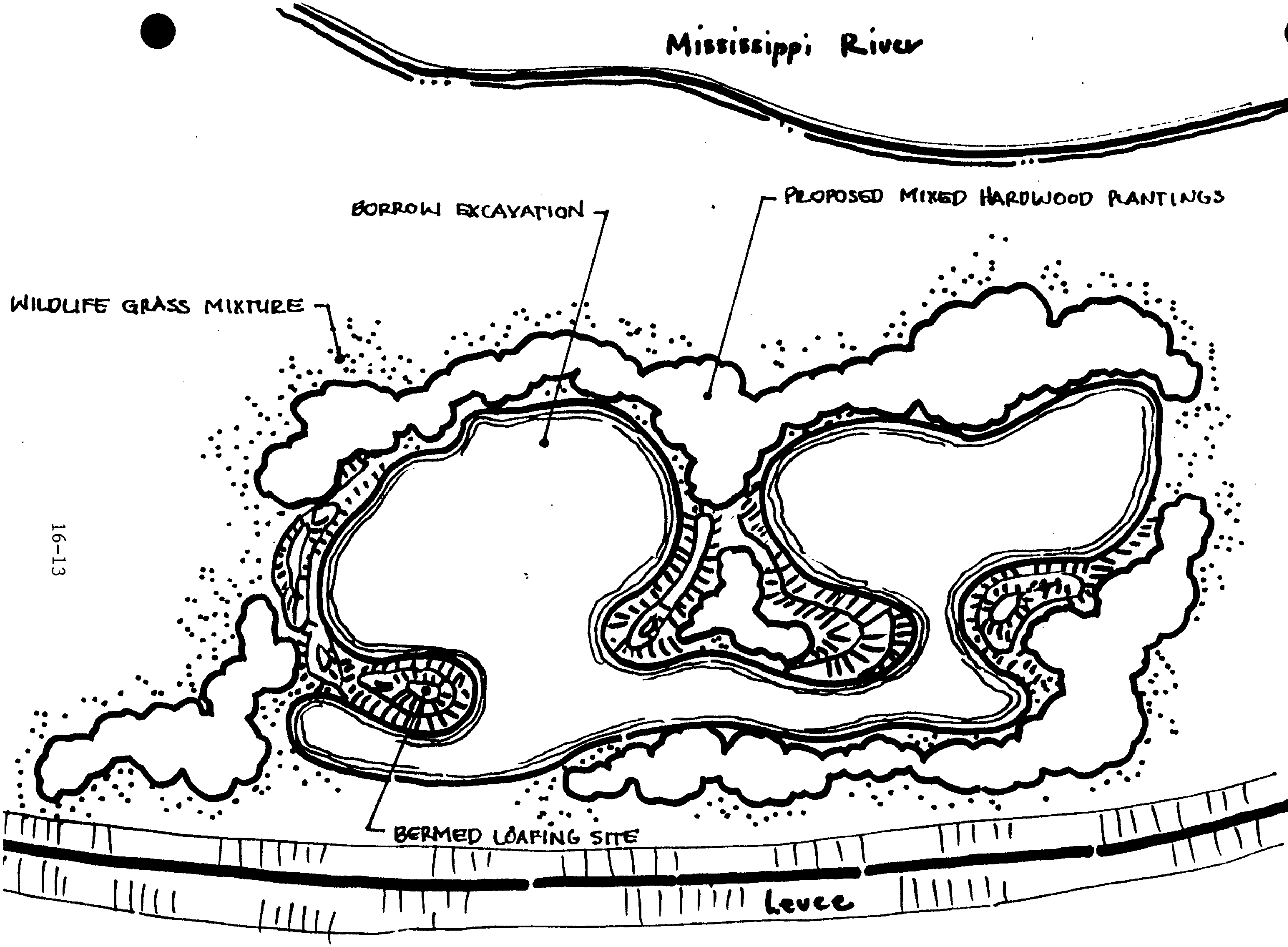
25. Less than 1 percent of the total acres in the project area would be impacted. Based on this small percentage, the net effect to the esthetics in constructing this project would be minor and insignificant.



TRADITIONAL BORROW AREA
(USUALLY TAKEN FROM FORESTED AREAS ON RIVERSIDE)

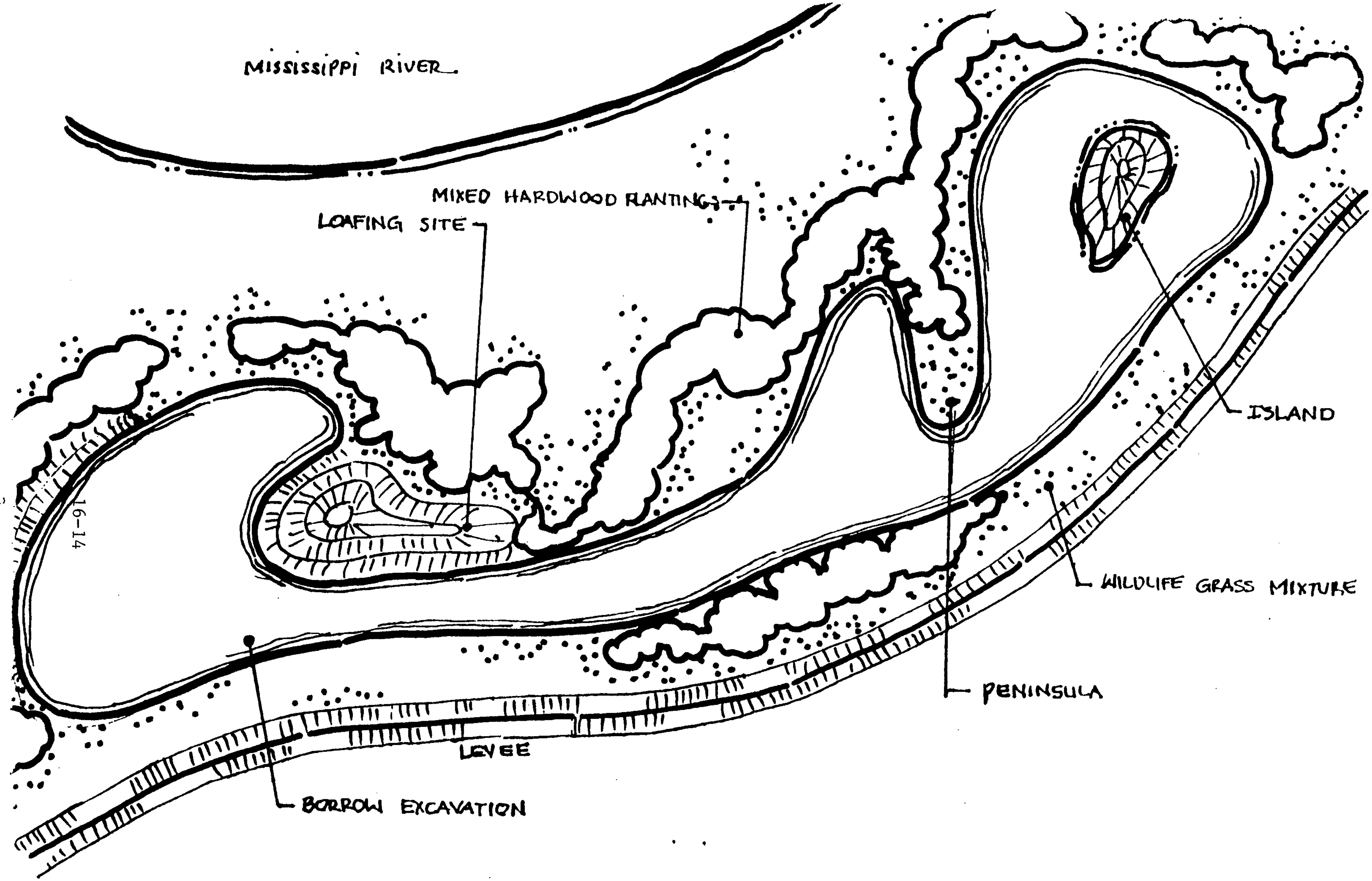
FIGURE 16-1


MISSISSIPPI RIVER
EXISTING HARDWOODS
PLACE CUT DOWN TREES IN WATER AND COVER W/ 1½' EXCESS FILL TO CREATE HABITAT
1 ON 3 SLOPE
BORROW AREA EXCAVATION
WILDLIFE GRASS MIXTURE
1 ON 3 SLOPE
TYPE A' BORROW AREA
(1-10 ACRES)



TYPE B · BORROW AREA
(10 - 30 ACRES)

FIGURE 16-3



TYPE C · BORROW AREA
(OVER 30 ACRES)

FIGURE 16-4

APPENDIX 17
WATER QUALITY ANALYSIS

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 17
WATER QUALITY ANALYSIS

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MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
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APPENDIX 17
WATER QUALITY ANALYSIS

INTRODUCTION

1. Currently, significant reaches of the Mississippi River Levees within the U.S. Army Corps of Engineers, Memphis, Vicksburg, and New Orleans Districts, are deficient. In order for these levees to provide flood protection for the Lower Mississippi Valley from the project design flood, improvements are required. These improvements include both raising sections of levee and providing berms or alternate means to prevent seepage from undermining the levees. In the past, most of the material used to build the levees and the berms has come from riverside borrow areas. For some work items, the borrow material was obtained landside of the levees. The remaining items of work call for the construction of more borrow areas. Most of these areas will be constructed riverside of the levees. Generally, these borrow areas are located adjacent to the work items to reduce hauling distances. However, in order to reduce the loss of bottom-land hardwoods, alternate sites both riverside and landside of the levees are being considered. Borrow areas constitute 32 percent of the available permanent slack-water aquatic environment in the batture area (Baker, 1991) and are highly productive fishery habitat (Cobb, 1984). Borrow areas are nursery areas for many species of fish (Beecher, et al., 1977; Fischer and Kelso, 1988; Leitman, et al., 1991), and add fish back to the river (Sabo and Kelso, 1991, and Sabo, et al., 1991). With the additional area added as a result of this project, borrow areas will compose up to 42 percent of the available slack-water habitat. As such, they are important features of the aquatic environment in the project area. In addition to borrow area options, alternative measures to berms will be examined to reduce the potential of levee failure due to seepage. Such measures include relief wells and slurry cutoff trenches. This appendix examines the direct and indirect impacts to water quality from raising the levees, construction of levee berms, installation of relief wells, and construction of trenches. Previous levee work has resulted in numerous borrow areas being created along the Mississippi River. The best way to estimate expected water quality within the proposed new borrow areas is to evaluate the water quality of existing areas. This appendix provides a water quality evaluation of 17 riverside and 5 landside existing borrow areas along the Mississippi River within the project area. Twelve riverside areas and 1 landside area were evaluated during 1996. Five existing riverside areas (three in the Memphis District and two in the New Orleans District) and four additional landside borrow areas, all in the Vicksburg District, were studied in 1997. Three of the 12 areas in the Vicksburg District that were evaluated in 1996 were reexamined during 1997. In addition to the borrow areas, nine oxbow lakes or abandoned river channels along the Mississippi River were evaluated in 1997. Of these lakes and channels, four were in the Memphis District, four in the Vicksburg District, and one in the New Orleans District.

BACKGROUND INFORMATION

2. The Lower Mississippi River Environmental Program (LMREP) was initiated in 1981 by the Mississippi River Commission. This program was a comprehensive study with two basic objectives. The first objective was to develop baseline environmental resource data on the lower Mississippi River and the associated leveed flood plain. The second objective was to formulate environmental design considerations for the main stem levee system and channel improvement works. The LMREP included detailed investigations of 25 existing riverside borrow areas along the lower Mississippi River. These areas were located within the Memphis, Vicksburg, and New Orleans Districts. Sixteen of the riverside borrow areas evaluated for the current study were investigated in the LMREP. The Levee Borrow Pit Investigations of the program included detailed fish, benthos, sediment and water quality data collection, and field surveys to describe the physical characteristics and terrestrial and aquatic wildlife use of the selected borrow areas. The sediment and water quality evaluation was limited to grain-size distribution and in situ surface and subsurface data.

3. Figure 17-1 is a map of the lower Mississippi River that locates the five landside borrow areas (LBP and LPIT) and nine oxbow lakes/abandoned channels evaluated in this water quality analysis, the sixteen riverside borrow areas evaluated in this analysis and the LMREP, and the one riverside area evaluated in this analysis but not in the LMREP. Table 17-1 provides a more detailed location of the water quality sampling areas for this current evaluation. These areas are located throughout the project area from River Mile 180 to 910. The borrow area numbers assigned to the riverside areas correspond to those used in the LMREP. Of the riverside borrow areas, 11 are located in Louisiana, 4 in Mississippi, and 2 in Arkansas. All five of the landside borrow areas are located in Louisiana. Of the oxbow lakes/abandoned channels, one is in Missouri, one in Tennessee, one in Arkansas, three in Mississippi, and three in Louisiana.

4. Previous studies vary in their results concerning contamination of the Mississippi River. Some have labeled the Mississippi River system as heavily contaminated while others indicate that while some water quality parameters may exceed limits, in general, the water quality is acceptable. Pollution of the Mississippi River prior to the mid-1970's was primarily attributed to the release of improperly treated wastewater into the main stem and tributaries. With the passage of the Clean Water Act in 1972, water quality within many of the streams within the United States, including the Mississippi River, improved. Currently, the primary source of pollutants in the Mississippi River is nonpoint agricultural, including pesticides, herbicides, and fertilizers (EPA, 1988; USGS, 1995). The water quality of the Mississippi River and some of its tributaries was intensively studied from 1987 through 1992 by the U.S. Geological Survey (USGS). During 1987-1990, sampling was conducted between Winfield, Missouri, and New Orleans, Louisiana. Winfield is located approximately 100 kilometers upstream of St. Louis, Missouri. During 1991-1992, the sampling program was expanded to include the upper Mississippi River. Sampling was conducted during those years between Minneapolis, Minnesota, and New Orleans. The results of this sampling program are presented in multiple reports and are summarized in USGS Circular 1133, "Contaminants in the Mississippi River, 1987-92." The USGS analysis concluded that nitrate, most likely from fertilizer, was the only nutrient compound that represents a problem within the Mississippi River system. The USGS also concluded that nitrate concentrations in many tributaries in Iowa, Minnesota, and northern Illinois approach and occasionally exceed the Environmental Protection Agency (EPA) drinking water standard of

10 milligram per liter (mg/L). The high levels of nutrients and sediments in the Mississippi River have created a zone of low dissolved oxygen in the Gulf of Mexico. This zone of hypoxia has been growing and now poses a threat to the Gulf of Mexico fisheries. For trace metals, the analysis concluded that concentrations dissolved in the water of the Mississippi River were well below EPA guidelines for drinking water and water that supports aquatic life. However, trace metals in the suspended sediments exceeded the pollution guidelines at many of the main stem sampling locations. While pesticides were detected and may have briefly exceeded health-based limits for drinking water, concentrations generally were highest during runoff from the first storms after application. The average annual concentrations of all pesticides measured in the Mississippi River were well below health-based limits.

5. Each of the existing riverside borrow areas is flooded by the river during periods of out-of-bank flow. However, the frequency of this inundation varies among the borrow areas. The LMREP shows that the percent of days flooded between 1973 and 1981 ranged from 7 percent for BP-17 to 30 percent for BP-7. Since the borrow areas and the river are hydraulically connected during high water, it is likely that a relationship exists between water quality within the riverside borrow areas and water quality within the river. However, a definite relationship could not be established due to the limited water quality data set available and the many variables such as time of year, flow rate, etc., upon which water quality is dependent. Since the hydraulic connection is not continuous, the water quality in the borrow areas can vary from that of the Mississippi River. As ample information already exists, no new general analysis of the water quality in the Mississippi River has been conducted for this study. Because the water quality in the borrow areas is not well defined and the creation of borrow areas is an important project feature, this water quality analysis will focus on the water quality in the existing borrow areas and other similar features of the batture lands such as oxbow lakes and abandoned channels.

6. Historical water quality data were retrieved from the EPA's STORET database for four USGS monitoring stations. The data are summarized in Table 17-2. The data represent samples collected from 1973 to 1994 at Memphis, Tennessee, and Vicksburg, Mississippi, and from 1973 to 1996 for New Orleans, Louisiana, and Venice, Louisiana. These data support the conclusions of the USGS study regarding nutrient levels in the Mississippi River (USGS, 1996). Nitrate levels exceed the Mississippi benchmark of 1.0 mg/l at all stations in 75 percent of the samples. Total Kjeldahl Nitrogen (TKN) levels exceed the 1.0 mg/l benchmark in 50 percent of the samples at Memphis and in more than 25 percent of the samples at the other stations. These benchmarks are not water quality criteria, but are benchmarks used by the Mississippi Department of Environmental Quality (MDEQ) to assess water bodies for the biannual Clean Water Act Section 305b Report. The MDEQ uses them to determine if a water body is supporting the designated use of fish and wildlife propagation (FWP). Based on these benchmarks, the MDEQ rates the Mississippi River as partially supporting FWP. Louisiana uses dissolved oxygen levels to determine if a water body supports FWP. Louisiana divides the Mississippi River into four reaches. Reach 1 starts at the Arkansas-Louisiana State line and goes to Old River. Reach 2 starts at Old River and extends to Monte Sano Bayou just upstream of Baton Rouge. Reach 3 goes from Monte Sano Bayou to "Head of Passes", while Reach 4 extends from "Head of Passes" to "Mouth of Passes." All four reaches are rated as fully supporting FWP, but the support in Reach 3 is threatened (LA DEQ, 1996). The State of Arkansas rates the Mississippi River as partially supporting FWP. The Arkansas Department of Pollution Control and Ecology (APC&E) based the determination on dissolved oxygen, turbidity, and other factors (APC&E, 1996). All states base the support of primary contact recreation (PCR) and secondary contact recreation (SCR) on fecal coliform levels. The determinations for designated use support for all

seven states are found in Table 17-3. The two major goals of the Clean Water Act (FWPCA, 1972) were to make the Nation's surface waters fishable and swimmable by 1985. These goals were not fully accomplished. Achievement of the swimmable goal, also called primary contact recreation (PCR), is determined by fecal coliform counts. High coliform counts are generally an indicator of contaminants from municipal wastewater and/or livestock. Secondary contact recreation (SCR) which refers to wading, boating, or jet skiing type activities is also assessed by coliform counts. Each state is required to file a biannual report to the EPA assessing the status of its waters. A review of the reports prepared by the States of Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana indicates that most of these states either did not assess the Mississippi River for swimmability or only assessed small sections of the river (see Table 17-3). Louisiana did assess the entire river within its jurisdiction and found that 369 miles supported primary and secondary contact recreation, while 344 miles did not support these uses. The determination of support of aquatic life or fish and wildlife propagation varied considerably between states. Louisiana based it on dissolved oxygen. Mississippi based it upon benchmarks for several physicochemical parameters. Arkansas, Tennessee, Kentucky, Missouri, and Illinois based it on aquatic life criteria. For those states, if no more than 10 percent of the samples exceeded an aquatic life criteria, the waters were fully supporting. If the criteria were exceeded in 10 to 24 percent of the samples, then the waters were partially supportive. If a criterion was exceeded in more than 25 percent of the samples, then the waters were not supportive of aquatic life.

7. Table 17-2 also includes the available trace metal and pesticide data for the four stations. Due to inconsistencies in how the data were reported and changes in analytical capabilities, the data are subject to some misinterpretation. When the data are stored in the data base, each value is stored with a corresponding letter code. Undetected values are generally given a "U" code, while less than values are generally given a "K" code. However, some undetected values were reported as "0" without the U code, and many less than values were reported as the detection limit without the K code. For instance, none of the pesticide data from the Vicksburg station had a U or K code, but all of the observed values were zeros.

8. The detection limits for many parameters have improved over the years. Total lead had an initial detection limit of 200 μg/l. That limit then went to 20, to 10 and now is 5 μg/l. The use of data with such wide ranging detection limits complicates the estimation of mean observed values and compliance with water quality criteria. In order to provide a clear picture of past and present water quality based on STORET data, two sets of dissolved trace metal statistics are presented in Table 17-2 for each trace metal. The data have been subdivided into two periods. The first period includes all data collected at each station through 1986, while the second period includes the data collected from 1987 to the present. The EPA recommends that states use at least 3 years of data when assessing stations for compliance with designated uses. This report will only compare the more recent data set to the aquatic life criteria. By using the data starting in 1987, the results will be comparable to the USGS study of Mississippi River water quality, which started in 1987. Most of the errors in the STORET data are associated with the older data. By subdividing the data, the analysis will not be impaired by the inconsistencies associated with the older data and the results will better reflect the current water quality in the Mississippi River. The trace metal and pesticide data presented in Table 17-2 are provided with two mean values. The first value is the mean calculated from samples with detectable quantities (the code value was not a "K" or a "U"). The second is the mean of all samples. Samples with a "K" code were assigned a value equal to one half of the detection limit. One-half the detection limit was used for two reasons. The first is so "less than" values can be distinguished from observations equal to the detection limit. The second reason is that "less than" values will likely have a real value

greater than zero and less than the detection limit. If the real values are normally distributed, the mean will be close to .5 times the detection limit. In general, the mean of all samples will be less than the mean of the detections. The means will be close if most of the samples were detections. When there is a high percentage of "less than" values, the mean of all samples can be substantially different. The mean of all samples for total lead is higher than the mean of the detections, because the initial detection limit was 200 μg/l. This high detection limit skewed the mean. Two criteria are provided in the table for comparison with the observed values. The two criteria are the fresh water acute (FWA) and the fresh water chronic (FWC). These criteria are generally based on the results of laboratory bioassays. The FWA is generally based on 96-hour acute toxicity tests and represents the LC50 (median lethal concentration) of the most sensitive organism. It represents the concentration of the toxicant which is lethal to 50 percent of the test organisms in a 96-hour test. The FWC is based on the maximum acceptable toxicant concentration (MATC) which is the geometric mean of the NOEC (no observable effect concentration) and the LOEC (lowest observable effect concentration) of the species most sensitive to chronic exposure of the toxicant. A chronic bioassay exposes organisms to the toxicant for a period greater than 10 percent of the organisms life cycle. Chronic bioassays measure the sublethal effects in such areas as reproduction, development, growth and behavior. The FWC for mercury was derived from the FDA action level for mercury (1.0 mg/kg) and the bioconcentration factor of the fathead minnow (81,700). The FWA criteria are not exceeded at any station for any trace metal. Most of the states in the study area use only the FWA criteria to determine if a water body supports aquatic life. Mississippi uses several benchmarks for nutrients and solids in addition to the FWA to make the determination, while Louisiana uses DO levels as the primary determinant. Although the FWA criteria are not exceeded by any of the trace metals, the FWC for some trace metals are occasionally exceeded. The FWC criterion for cadmium is exceeded by the 90th percentile level at Memphis and Vicksburg, while the FWC criterion for copper is exceeded by the 90th percentile level at Memphis. The FWC criterion for mercury is exceeded by the 90th percentile level at every station. The other percentile ranges exceed the FWC for mercury, but only the 90th percentile represents detected quantities. The detection limit for mercury also exceeds the FWC for mercury. Interpretation of data when the criterion is below the detection limit is difficult at best. The USGS used ultraclean sampling techniques during their study of Mississippi River contaminants. By using those techniques, they were able to achieve detection limits below the .012 μg/l FWC for mercury. Although some individual samples exceeded the FWC criterion, the average value at most stations was below the FWC level. Overall, the trace metal levels in the Mississippi River at all stations indicate that the waters support the propagation of aquatic life. Organochlorine pesticides were infrequently detected at all stations. The means of the "detected" samples for most pesticides are zero. This means that no pesticides were detected and that the reported value was incorrectly reported as zero with no "U" code. Only three pesticides were detected at the four stations. Each pesticide was detected only once. The three pesticides were dieldrin, DDT, and endrin. The detected value for each pesticide exceeded the respective FWC criterion. Most of the pesticide data in the STORET data base is old. The data sets collected by the USGS (1987-1992) and the Corps (1996-1997) are more current and provide a better means of assessing water quality conditions in the Mississippi River.

WATER QUALITY SAMPLING

9. Water quality samples (both water and sediment) were collected by the Vicksburg District at each of 13 borrow areas during May 1996. These sites include BP-1, BP-2, BP-3, BP-4, BP-5, BP-6, BP-7, BP-8, BP-9, BP-10, BP-12, BP-18, and LBP-1. One water and one composite sediment sample were collected in most of the borrow areas. Composite samples were obtained

by collecting sediment samples at two or three locations within a borrow area and mixing the samples prior to testing. Duplicate sediment and water samples were taken in BP-4, BP-8, BP-9, BP-12, and LBP-1. Duplicate samples are additional samples taken at a sampling location and are used for quality control. Since samples were collected from each borrow area on only one day, they describe the conditions at the sampling time and may not necessarily represent the average water and/or sediment quality of the borrow areas. The samples were analyzed by the U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Analytical Laboratory Group. Table 17-4 lists the various parameters analyzed which include in-situ, physicochemical including nutrients, and priority pollutants (pesticides, PCB's, and metals). Thirteen priority pollutant metals, 4 nonpriority pollutant metals, 19 pesticides, and 7 PCB's were quantified in both the water and sediment samples for each of the 13 borrow areas sampled in 1996. An additional 103 priority pollutants were analyzed in the water samples of 5 borrow areas. The sites for the additional analyses are: BP-4, BP-7, BP-8, BP-12, and LBP-1. During 1997, the water quality study was expanded to include existing riverside borrow areas in the Memphis and New Orleans Districts, additional existing landside borrow areas in the Vicksburg District , and oxbow lakes/abandoned channels in all three Districts. Three riverside borrow areas were sampled in the Memphis District (BP-13, BP-15, BP-17) and two in the New Orleans District (BP-25, BP-Goula). Four additional landside borrow areas were sampled (LPit-1, LPit-2, LPit-3, LPit-4) . Sediment samples were collected from the borrow areas and analyzed for nutrients and selected priority pollutants (trace metals, pesticides, herbicides, and 103 additional organic compounds). In addition, due to the relatively high mercury levels discovered in the sediments of some of the borrow areas sampled in 1996, fish tissue samples were collected from borrow areas and analyzed for the same priority pollutants as the sediments. The Mississippi River oxbow lakes and abandoned channel areas, like the borrow areas, are heavily fished by recreational and commercial fishermen and would likely have similar sediment mercury levels. Both sediment and fish tissue samples were collected from these areas. Nine oxbow lakes/abandoned channels were sampled. These include Island No. 8, Chisolm Lake, Brandywine, and Tunica Lake in the Memphis District; Lake Whittington, Palmyra Lake, Yucatan Lake, and Lake Mary in the Vicksburg District; and Raccourci in the New Orleans District.

SURFACE WATER QUALITY

10. Table 17-5 presents the general water quality data (in situ data plus turbidity) for each of the 13 borrow areas sampled during 1996 and 9 of the borrow areas sampled during 1997. Water temperature varied between the borrow areas, with depth within each area, and with time of year that the samples were collected. Temperature ranged from 17.4 degrees C at 3 meters (m) below the surface in BP-9 and BP-10 to 37.9 degrees C at the surface in BP-15. The May 1996 temperature readings compare very well with temperatures recorded during May of previous years at Lake Chicot (a large Mississippi River oxbow lake in Arkansas). Temperature readings in BP-15, BP-13, and BP-25 exceeded the Mississippi and Louisiana Departments of Environmental Quality (DEQ) maximum temperature criteria of 90 degrees F (32.2 degrees C). All three of these borrow areas were sampled during August. Mean hydrogen ion concentrations (pH) ranged from 6.7 in BP-18 to 8.4 in LPit-3. The minimum pH measured was 6.6 at 3 m below the surface in BP-9 and BP-18. Maximum measured pH was 8.6 at the surface of LPit-3 and LPit-4. All of the pH readings were circum neutral and within the criteria ranges of the seven states in the project area. Mean dissolved oxygen (DO) concentrations ranged from 0.3 mg/L in BP-18 to 10.9 mg/L in BP-3. The mean DO concentrations for BP-17, BP-13, BP-9, LBP-1, BP-7, BP-10, BP-18, and BP-Goula were below the minimum criteria of 5.0 mg/L. However, DO concentrations measured at the surface in each borrow area except BP-17 and BP-18 exceeded the minimum criteria of 5 mg/L. Mean conductivity levels ranged from 139.3 μmhos/centimeters

(cm) in LPit-3 to 353 μmhos/cm in BP-18. All conductivity levels were well below the Mississippi DEQ criteria of 1,000 μmhos/cm. Mean turbidity within the borrow areas ranged from 2.8 nephelometric turbidity unit (NTU) in BP-18 to 132 NTU in LPit-4. Mean turbidity in BP-4, BP-5, BP-8, BP-10, and BP-12 exceeded the Louisiana and Arkansas criteria of 25 NTU for lakes. However, at the time that these samples were collected (May 1996), the Mississippi River was high enough to be flowing into all of the sampled riverside borrow areas. The mean turbidity in BP-17, BP-15, LPit-2, LPit-4, BP-Goula, and BP-25 also exceeded the Louisiana and Arkansas criteria for lakes. All of the turbidity measurements were below the Louisiana DEQ criteria of 150 NTU for the Mississippi River.

11. The water samples from each borrow area were analyzed for the physicochemical parameters of total Kjeldahl nitrogen (TKN), total phosphorus (TP), orthophosphate (SRP), sulfate, total solids (TS), and total suspended solids (TSS). Table 17-6 contains these parameter concentrations. This table shows that for TKN, only one sample, one of two samples collected in LBP-1, exceeded the State of Mississippi DEQ benchmark of 1.0 mg/L. TKN is a measure of organic nitrogen and is the product of the transformation of inorganic nitrogen into organic nitrogen by plants. Since LBP-1 is located on the landside of the levee in an active agriculture area, high nitrogen levels in this borrow area would not be unexpected due to runoff. All of the other samples, including the second sample taken in LBP-1, had TKN quantities well below the benchmark. The TKN for the second LBP-1 sample was 0.415 mg/L. The mean TKN for all samples including LBP-1 was 0.377 mg/L. The mean TKN for the samples excluding LBP-1 was 0.327 mg/L. The analysis results for TP and orthophosphate had discrepancies since for some samples, orthophosphate levels exceeded TP. In laboratory testing, total samples containing reduced iron had the phosphorus striped from the sample when the iron oxidized and precipitated. Therefore, in those samples with this discrepancy, TP is assumed to equal orthophosphate. Table 17-6 shows that the Mississippi DEQ benchmark of 0.3 mg/L for TP was exceeded in BP-4, BP-5, BP-8, BP-9, BP-10, BP-12, and BP-18. The mean TP for all samples was 0.244 mg/L. Sulfate concentrations in all of the riverside borrow area samples ranged from 36.5 to 46 mg/L. In the landside borrow area (LBP-1), sulfate was less than 4 mg/L. The TSS concentrations ranged from 6 to 30 mg/L with a mean of 17 mg/L. TS for all samples excluding LBP-1 ranged from 185 to 270 mg/L with a mean of 214.9 mg/L. TS in LBP-1 was less than in the riverside areas with values for the two samples collected of 136 and 134 mg/L.

12. No pesticides in concentrations above trace amounts were detected in any of the borrow area water samples. Trace amounts of Gamma-BHC in BP-2, Endosulfan Sulfate in BP-4, and Heptachlor Epoxide in BP-4 and BP-9 were detected.

13. National criteria for acceptable levels of certain metals in water are provided by EPA in EPA 440/5-86-001, "Quality Criteria for Water 1986." Each state must adopt criteria equal to or more stringent than the EPA's criteria. The freshwater criteria are provided as acute (short-term) and chronic (long-term). The impact of some trace metals in water is dependent upon the hardness of the water. These metals include nickel, lead, copper, chromium, cadmium, and zinc. The harder the water, the less the impact of the metal. EPA 440/5-86-001 provides formulas based on hardness to calculate the acute and chronic criteria for cadmium, chromium, copper, lead, and nickel. In 1997, the Louisiana DEQ published "Final Rule, Environmental Quality, Louisiana Surface Water Quality Standards," which provides formulas for calculating the criteria for zinc. These formulas provide more restrictive criteria than the EPA criteria. The average

hardness for the Mississippi River water as determined from water samples collected by USGS in 1992 at Vicksburg is 140 mg/L. Waters with this magnitude of hardness are rated as moderately hard. Based on this hardness level, acute and chronic criteria for cadmium, chromium, copper, lead, nickel, and zinc were calculated.

14. Metals concentrations of each of the water samples are presented in Table 17-7. These metals include arsenic, chromium, copper, lead, nickel, zinc, barium, iron, and manganese. The samples were also analyzed for cadmium, mercury, selenium, and cobalt. However, none of these four metals were detected in any of the samples. Arsenic was detected in three borrow areas. These borrow areas were BP-6, BP-18, and LBP-1 (both samples). All three borrow areas had arsenic levels well below the EPA acute and chronic criteria. Chromium was detected in BP-8, BP-9, and LBP-1. However, the concentrations were extremely low. Duplicate samples were taken in each of these three borrow areas. In all three areas, chromium was detected above detection limits in only one of the two samples collected. Copper was detected in 8 of the 13 borrow areas. None of the concentrations exceeded 3 micrograms per liter (μg/L) which is well below the acute and chronic criteria. Lead was detected in only three borrow areas (BP-5, BP-8, and BP-12). The observed concentrations of lead in all three of these areas were below the acute and chronic criteria. Nickel was detected in all borrow areas except BP-6. However, the concentrations were extremely low and well below the national criteria. Zinc was detected in only two borrow areas (BP-5 and BP-8). Like nickel, the concentrations were extremely low and well below the acute and chronic criteria. Barium, iron, and manganese were detected in all 13 borrow areas. The highest levels of barium were detected in the landside borrow area. No national criterion exists for barium. The highest levels of iron were detected in BP-5. The iron concentration in this area was significantly higher than in other areas. Only a chronic criterion exists for iron. The concentration detected in BP-5 exceeds this criterion. The highest concentration of manganese was detected in BP-18. The level of manganese in this area was significantly higher than in the other areas. However, no national criterion exists for manganese.

SURFACE SEDIMENT QUALITY

15. The sediment samples from each borrow area and oxbow lake/abandoned channel were analyzed for TKN, TP, sulfate, and total organic carbon (TOC). These parameters are presented in Table 17-8. The TKN concentrations ranged from less than detectable concentrations in BP-17, Brandywine, Tunica, BP-15, BP-13, Lake Whittington, Yucatan, BP-18, and Raccourci to 344 milligrams per kilogram (mg/kg) in BP-8. The TP levels ranged from 34.3 mg/kg at Island No. 8 to 773 mg/kg at BP-25. The sulfate concentrations for samples BP-7 and BP-12A were significantly higher than the other samples. Concentrations in these areas were more than twice as high as the mean concentration for all samples. TOC levels ranged from 56.2 at Island No. 8 to 27,700 at BP-7. The TOC in BP-7 was significantly higher than any of the other samples.

16. The major problem in assessing the quality of sediment is that no nationally accepted sediment criteria exist. While various criteria have been applied or proposed on a regional basis, none have been officially accepted on a national scale. Only recently has the EPA proposed sediment criteria for any contaminants. These include endrin, dieldrin, and three polycyclicaromatic hydrocarbons (PAH's). In March 1990, the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Office of Oceanography and Marine Assessment, published Technical Memorandum NOS OMA 52, "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program." This report provides two statistically calculated benchmarks for many

contaminants that have a sufficiently large data set to satisfactorily determine the benchmarks. These benchmarks are referred to as "Effects Range-Low" (ER-L) and "Effects Range-Median" (ER-M). The ER-L represents the 10th percentile level of accumulated environmental effects data. It represents a low level benchmark. The ER-M represents the 50th percentile of the range of contaminant levels that produce environmental effects. Sediments with contaminant concentrations less than the ER-L represent a minimal effect range in which adverse biological effects would be rarely observed. Contaminant concentrations equal to and greater than the ER-L, but less than the ER-M, represent a probable effects range in which effects would occasionally occur. Sediments with contaminant concentrations that exceed the ER-M represent a probable effects range in which effects would frequently occur.

17. The only pesticide detected in concentrations above trace amounts was ppDDE in the duplicate samples collected in LBP-1. The ppDDE concentrations of 71 and 52 μg/kg in this borrow area exceed both the ER-L of 2.2 μg/kg and the ER-M of 27 μg/kg. The ER-M for ppDDE was established from an incidence of effects of 50 percent. This means that of the data entries with levels of ppDDE above 27 μg/kg, 50 percent experienced observed biological effects. Therefore, since the ppDDE concentrations in LBP-1 exceeded the ER-M, it is likely that biological effects due to ppDDE would occur in this borrow area. Trace amounts of ppDDE were detected in BP-3, BP-4, BP-5, BP-8, BP-9, and BP-10. These trace concentrations in BP-5, BP-8 (both samples), and in one of the two samples collected in BP-9 exceed the ER-L. Figure 17-2 is a plot of the ppDDE concentrations detected in the borrow areas. Total DDT concentrations (DDE + DDD + DDT) exceeded the ER-L of 1.58 μg/kg in BP-3, BP-4, BP-5, BP-8, and BP-9. Total DDT concentrations in LBP-1 exceeded the ER-M of 46.1 μg/kg. Trace amounts of Aldrin in BP-3 and Palmyra; Beta-BHC in BP-7, BP-8, BP-9, and Yucatan; Gamma-BHC in BP-3, Delta-BHC in BP-2 and Palmyra; ppDDD in LBP-1; ppDDT in BP-3; Heptachlor in BP-3, BP-6, LBP-1, and Palmyra; Dieldrin in BP-3 and Palmyra; Endrin Aldehyde in BP-3; and Heptachlor Epoxide in BP-12 were also detected.

18. Due to the high levels of ppDDE discovered in LBP-1 during the 1996 sampling, four additional landside borrow areas were sampled for pesticides during 1997. These four areas are located near Lake Providence, Louisiana, and are identified as LPit-1, LPit-2, LPit-3, and LPit-4 on Figure 17-1. These areas were selected by the sampling contractor (U.S. Army Engineer Waterways Experiment Station) primarily due to access availability. All four of these areas are located on the riverside of the existing mainline levee. However, the mainline levee at these areas is a setback, constructed in 1931. The abandoned levee, located riverward of the borrow areas, remains in place and has continued to provide flood protection since the setback was constructed. Therefore, all four of the borrow areas are surrounded by a ring levee. Available data indicate that this abandoned section of levee has never overtopped nor breeched since the setback was completed. However, a structure exists through the mainline levee to allow for draining of the area. At times, the Mississippi River does back up through this structure. Therefore, these four borrow areas are occasionally subject to being inundated by the waters of the Mississippi River and would not exhibit characteristics of true landside borrow areas. No pesticides were detected in the sediment samples collected from these four areas. The absence of pesticides is surprising since all four borrow areas are located in an intensively active agriculture area. However, the drainage area into these borrow areas is limited which may contribute to the lack of pesticides being found. Subsequent to sampling, it was found that new borrow areas were constructed next to the old ones in 1991. The sampling was done in the new borrow areas, as the old ones were completely filled with sediment.

19. Figures 17-3 through 17-11 are plots of detected metals concentrations in the sediment samples. While chromium (Figure 17-5), copper (Figure 17-6), and zinc (Figure 17-11) were detected in all the sampling areas, none of the concentrations exceeded their respective ER-L's. Selenium (Figure 17-10) was detected in all sampling areas except Island No. 8 and Palmyra. Barium, cobalt, iron, and manganese were only analyzed in the 13 borrow areas sampled during 1996. All four of these metals were detected in each of the borrow areas. However, no benchmark levels exist for selenium, barium, cobalt, iron, and manganese. Arsenic (Figure 17-3) was detected in all 36 of the samples collected. The ER-L for arsenic was exceeded in eight samples. These samples include one of three samples collected in LBP-1, the sample collected in BP-18 during 1997, Chisholm, Brandywine, Tunica, Whittington, Yucatan, and Raccourci. The mean for all the samples taken from all the borrow areas was below the ER-L. Cadmium (Figure 17-4) was detected in 35 of the 36 samples collected. The only sample in which cadmium was not detected was the sample collected from Island No. 8. The ER-L for cadmium was exceeded in seven of the sampling areas (BP-17, Tunica, BP-9, BP-7, BP-18 (1997 sample), and Raccourci) and was equaled in BP-8 (both 1996 samples). However, the mean for all samples was below the ER-L. Four of the samples that have levels exceeding the ER-L have concentrations much higher than the other samples (BP-17, Tunica, BP-18-1997, and Raccourci). ER-L for lead was exceeded in two samples, BP-15 and BP-13 (Figure 17-7). Both samples had lead concentrations much greater than any other sample. The two borrow areas are located close to each other and are immediately downstream from Memphis. The high lead could be from pollution or lead shot. Nickel (Figure 17-9) was detected in all 36 of the samples collected. The ER-L for nickel was exceeded in 25 of the samples and equaled in 2 other samples. The mean for all samples also exceeded the ER-L.

20. Mercury (Figure 17-8) was detected in 34 of the 36 samples analyzed. The only two samples in which mercury was not detected were Island No. 8 and one of the two samples collected in BP-4. The ER-L for mercury was exceeded in 14 of the samples. These 14 samples were all collected in 1996 and represent 9 different borrow areas. The mean of all samples also exceeded the ER-L. Figure 17-8 shows that the mercury levels varied between borrow areas, oxbow lakes, and abandoned channels and even between samples collected from the same area. The mercury concentration in one of the two samples collected in BP-18 exceeded the ER-M. Because of the high sediment mercury concentration in BP-18 observed in 1996, BP-18 was one of three borrow areas selected to be resampled in 1997. The 1997 results are an order of magnitude lower than the previous years' results. In fact, the sediment mercury levels of all samples collected in 1997 are less than the sediment mercury levels observed in the 1996 samples. There are several possible explanations for this observation. One is that the data from one of the years is in error. Another is that the high water of 1997 deposited large amounts of cleaner material in the sampled areas. The ER-M represents the median (50 percent) concentration of the observed range of biological effects. However, for mercury, there is an incidence of effects of 42.3 percent for samples which exceed the ER-M. This means that of the data entries with mercury concentrations above the ER-M level of 0.71 μg/kg, only 42.3 percent experienced observed biological effects. The incidence of effects percentage for other metals, except for nickel, is significantly higher than the mercury percentage. If the mercury concentration in BP-18 does exceed the ER-M, there is a moderate chance that biological effects due to mercury would occur in this borrow area. Mercury has a complex cycle in the aquatic environment. Methyl mercury is formed from inorganic mercury by sulfate-reducing bacteria. Methyl mercury formation is favorable in waters with low pH and low alkalinity. Mean pH values

in the sampled borrow areas were relatively high, ranging from 6.7 to 8.4. Alkalinity levels were not determined for the borrow area samples. However, historic mean alkalinity for the Mississippi River at Vicksburg is 99.5 mg/L. This alkalinity level is high for surface waters in the southeastern United States. Therefore, based on these higher pH and alkalinity levels, conditions are not favorable for the formation of methyl mercury in the borrow areas. Methyl mercury is the predominate form of mercury in fish tissue. BP-18 is located downstream of Natchez, Mississippi. USGS reported in Circular 1133 that the reach of the Mississippi River in the vicinity of this area contained higher dissolved mercury concentrations than in any other reach of the river. That mean was less than 3 parts per trillion over the 12 parts per trillion FWC criterion. Due to the somewhat higher dissolved mercury concentrations in that section of the Mississippi River, the observed sediment concentration there may not be representative of what will occur in borrow areas located in other reaches. The 1997 sediment samples collected from BP-18 and Lake Mary which is just across the river from BP-18 both had sediment mercury concentrations an order of magnitude less than the 1996 sediment sample from BP-18.

21. Table 17-9 provides a summary of the trace metal concentrations in sediment. This table also includes the mean, minimum, and maximum concentrations that naturally occur within the earth's crust. For all metals analyzed, concentrations were within the range that naturally occurs within the earth's crust except for cadmium. As shown in Table 17-9, USGS does not provide data for cadmium in the earth's crust. Samples collected from 13 of the sampled areas (BP-17, Tunica, BP-9, BP-8, Lake Whittington, BP-3, BP-5, BP-7, BP-10, Yucatan, BP-18, Lake Mary, Raccourci) had cadmium concentrations that exceed the maximum concentration of 0.7 parts per billion (ppb) in the earth's crust as reported by Bowen. In the previous paragraphs, the observed sediment metal concentrations were compared to the NOAA benchmarks. The observed sediment concentrations exceeded the ER-L for several trace metals. A measure of the reasonableness of an ER-L might be the difference between the ER-L and the mean concentration of that trace metal in the earth's crust. Three metals, whose observed sediment concentrations frequently exceeded their respective ER-L's, had mean concentrations very close to the ER-L level. Arsenic has a mean of 7.4 mg/kg and an ER-L of 8.2 mg/kg. The ERL-L was exceeded in 8 of the sediment samples. Mercury has a mean concentration of 0.12 mg/kg and an ER-L of 0.15 mg/kg, which was exceeded in 14 samples. Nickel has a mean concentration of 18.0 mg/kg and an ER-L of 20.9. The ER-L was exceeded or equaled in 27 sediment samples. These three metals also had low observed percent incidence of effects in the studies by Long (1993) for samples with concentrations between their respective ER-L's and ER-M's. Considering the low incidences of effect and the nearness of the ER-L's to the respective means suggests that these benchmarks may be too low.

FISH TISSUE QUALITY

22. Fish tissue quality tends to reflect sediment and water quality. Due to biomagnification, it may be a better indicator of water quality than water and sediment samples. Contaminant levels in fish are important for two reasons. They are an important consideration for human consumers, and high levels can cause acute or chronic responses in the fish. Fish tissue samples were not collected during 1996. However, the relatively high levels of mercury found in the sediments of many of the 13 borrow areas sampled during 1996 dictated the need for fish tissue sampling. During 1997, the water quality sampling program was expanded to include borrow areas in the Memphis and New Orleans Districts, additional landside borrow areas in the Vicksburg District, and oxbow lakes and abandoned channels in all three Districts. Also, three of

the borrow areas whose sediments were sampled in 1996 were resampled during 1997. Table 17-10 provides the dates that the water, sediment, and fish tissue samples were delivered to the Waterways Experiment Station, Environmental Laboratory for analysis and the date that the analyses were completed. The fish were collected from the sampling sites from 1 to 6 days prior to the delivered date. Table 17-11 identifies the analyzed fish by species and provides the length and weight of each fish. All the fish tissue samples were analyzed for priority pollutant metals, while representative samples were analyzed for organic pollutants including organochlorine pesticides. The sampling plan called for collecting eight fish from each sampling location, two predators from two species and two bottom feeders from two species. Because the primary concern was high fish tissue mercury levels, only fillets from edible-sized fish were analyzed. When fish tissue samples have not been obtained such as during the 1996 study, a procedure for predicting fish tissue levels from sediment pesticide concentrations is available. This procedure has provided very reliable predictions on other studies when compared to fish tissue samples. The procedure which allows for the assessment of current bioaccumulation potential of DDT and its metabolites is described by Clarke and McFarland (1991) in the report, "Assessing Bioaccumulation in Aquatic Organisms Exposed to Contaminated Sediments." This procedure provides for the calculation of the preference of an organic compound to be in the lipid tissues of fish or to be bound to the organic carbon in the sediments. The equation is:

$$TBP = pf\ (Cs/TOC) \times fl$$

where:

TBP = theoretical bioaccumulation potential
pf = preference factor
Cs = concentration of the organic contaminant in the sediment
TOC = total organic carbon content in percent or as a decimal fraction
fl = fish tissue lipid content in the same units as TOC

23. The only borrow area in which pesticides were detected above trace amounts in the sediment samples was LBP-1. Both samples obtained from this borrow area contained ppDDE. Previous studies indicate that the maximum preference factor for ppDDE should be 4.0. The lipid content for fish commonly ranges from 5 to 15 percent, depending upon the species. For fish typically found in Mississippi River borrow areas, a high lipid content of 10 percent was used. Based on these factors, a conservative theoretical bioaccumulation potential (TBP) for the two samples collected from LBP-1 were 2.9 and 2.1 mg/kg. These computed levels are less than the FDA action limit of 5.0 mg/kg for DDT and its metabolites, but they exceed the EPA screening value for human consumption (EPA, 1995). In previous studies (Upper Yazoo Projects Reformulation Study and Big Sunflower River Maintenance Project Final Environmental Impact Statement), TBP calculated with mean values of pf = 1.73 and fl = 7.5 percent have agreed well with observed fish tissue levels. Mean fish tissue pesticide levels by fish species are provided in Table 17-12 and the results of all assays are provided in Table 17-13. Using these mean values, TBP for the two samples collected from LBP-1 were 0.93 and 0.68 mg/kg. The observed total DDT (tDDT) levels from landside borrow area LBP-1 ranged from 0.047 to 4.19 mg/kg, with a mean observed level of 1.44 mg/kg. The observed levels bracket the predicted concentration range. Although no fish exceeded the FDA action level, a big-mouthed buffalo had a tDDT level of 4.2 mg/kg, which is just below the FDA action level. The mean observed level from LBP-1 is the same order of magnitude as the FDA action level. The EPA has developed screening values (SV) based on risk assessment for certain contaminants. The SV for tDDT is 0.3 mg/kg. The SV is based on the risk of one person in 100,000 getting cancer from a life time of exposure (including ingestion). The mean observed level in LBP-1 and all landside borrow areas exceeds

the SV. The mean observed dieldrin level in landside borrow areas also exceeds the SV for dieldrin (SV = 0.007 mg/kg). The observed levels of DDT and its metabolite DDE and DDD are highest in big mouth buffalo, channel catfish, and largemouth bass. The means of these fish species all exceed the EPA SV. The mean for the riverside fish does not exceed the SV, and the incidence of detecting the pesticides in riverside fish (45 percent) is considerably less than in landside fish (94 percent). These data suggest that fish from landside borrow areas are contaminated with high levels of DDT and dieldrin, but that the fish from riverside borrow areas are not contaminated with high levels of these persistent organochlorine pesticides. Nine fish from four riverside sites had detectable levels of PCB archlor 1260. The levels ranged from 0.031 mg/kg to 0.113 mg/kg. The EPA screening value for PCB's is 0.01 mg/l. The EPA completed a multiyear study on chemical residues in fish (EPA, 1992). In that study, the average concentration of PCB's in channel catfish was 1.3 mg/kg compared to 0.076 mg/kg in this study. Thus, although PCB levels in fish from this study exceed the SV, they are much less than the national average for fish. The EPA study divided the sites into 10 categories. Only the background site category had a lower mean for PCB's (0.047 mg/kg) than this study (0.071 mg/kg). In the EPA study, the four most frequently detected organic contaminants were PCB's, tDDT, nonachlor and dieldrin. The results of this study reflect those results, as tDDT, dieldrin, and PCB's were the three most frequently detected organics in this study. The FDA action levels were created to protect humans that consume fish from high levels of pesticides. It is not meant to imply that fish are safe if their tissue levels are less than the action level. The toxicity testing that was performed to establish the FWA and FWC criteria often included the testing of contaminant tissue concentrations. The EPA's report on DDT, "Ambient Water Quality Criteria for DDT" (1980) lists the maximum permissible tissue concentrations determined for specific species for an effect; such as, 0.15 mg/kg in brown pelicans to protect against reduced productivity or 0.5 mg/kg in brown pelicans to protect against egg shell thinning. Recent research from the University of Florida in Gainesville has found DDE to be an endocrine disrupter at very low tissue concentrations in alligators. Dr. Guillette has been studying the effect of a DDT spill in Lake Apopka, Florida, on alligators (Science News, August 1994). Alligators in the lake have low percent hatch and low hatch survival. Male alligators that do survive do not develop as proper males. Dr. Guillette first thought the DDE was an estrogen inhibitor, but he later postulated that DDE was an androgen blocker. Dr. L. Earl Gray, Jr., a toxicologist with the EPA in Athens, confirmed that DDE was an androgen blocker (Kelce, 1995). He found that it was an effective blocker at tissue concentrations of 60 μg/kg. DDE levels in fish tissue from this study ranged from 1 to 3,800 μg/kg. The mean DDE level for landside fish exceeds 60 μg/kg and reproductive interference is probable in landside borrow areas. Research is needed to determine what levels of DDE are needed to block androgen receptors in fish.

24. The trace metal concentrations in fish tissue are tabulated in Table 17-14. The concentrations are reported by fish species. Results of the FWS National Contaminant Biomonitoring Program are tabulated near the bottom of the table for comparison. The fish tissue trace metals concentrations in this study are within the ranges determined by the FWS. The means for most metals are less than the means in the FWS study. The observed mean concentrations of selenium (Se) for bluegills (0.50) and black crappie (0.53) exceed the mean Se concentrations in the FWS study (0.46 mg/kg). The fish tissue concentrations of most metals are related to their solubilities in water and thus their concentrations are nearly equal in all species. Mercury is the exception to this rule. Fish are able to eliminate inorganic mercury, but they cannot eliminate methyl mercury. Methyl mercury is a neurotoxin in fish and the fish respond by storing methyl mercury in their muscle tissue. Because fish are unable to eliminate methyl mercury, it biomagnifies in the food chain. Thus, top predators like channel catfish and

largemouth bass have higher levels of mercury in their tissue than bottom feeders or lower level predators. As a part of the "National Study of Chemical Residues in Fish," the EPA collected mercury fish tissue data. That report provides mean mercury levels for several species of fish that are in this study. The EPA mean for largemouth bass was 0.46 mg/kg and this study has a mean of 0.40 mg/kg. The EPA mean for flathead catfish was 0.27 mg/kg and this study's mean was 0.15 mg/kg. The EPA mean for channel catfish was 0.09 mg/kg and this study had a mean of 0.108 mg/kg. The means from this study were lower than the national means for 2 of the 3 species where both data sets have information. The only trace metal with an FDA action level is mercury. The action level is 1.0 mg/kg. No fish in this study has a mercury concentration exceeding 1.0 mg/kg. The highest observed levels are in the predator fish, such as largemouth bass (LMB). The fish tissue level which triggers fish consumption advisories varies between states. The states in this project area use either 1.0 mg/kg or 0.5 mg/kg. Only two LMB exceed the Louisiana advisory level of 0.5 mg/kg. The means for other fish are less than 0.21 mg/kg. Even though mercury is the only metal with an FDA action level, the State of Mississippi has levels of concern for 6 other trace metals. The level of concern for As, Pb, Se, Cd, and Cr is 1.0 mg/kg and the level of concern for Cu is 5.0 mg/kg. All fish sampled in this study are below those levels of concern. The EPA has risk-based screening values (SV) for several metals. The SV for those metals are: Cd, 10 mg/kg; Hg, 0.6 mg/kg; Se, 50 mg/kg; and As, 3, mg/kg. The fish consumption advisories issued by states for mercury are based on risk analysis and were discussed above. The observed fish tissue concentrations in this study do not exceed any of the other SV's. In general, the observed fish tissue trace metal levels in this study are low, indicating good water quality conditions.

SUMMARY OF WATER QUALITY FINDINGS

25. In general, the water quality within the sampled existing borrow areas was good. No pesticides in concentrations above trace amounts were detected in any of the borrow area water samples. While some metals were detected in the water samples, only iron in BP-5 exceeded national criteria. All other detected metals concentrations were well below both acute and chronic criteria. The sediment quality within the sampled areas was good even though samples from some borrow areas did exceed NOAA benchmarks. The two most notable exceedances were the high levels of mercury found in the sediment of one riverside borrow area (BP-18) in 1996 and of ppDDE found in the sediment of the landside area (LBP-1). The mercury level in BP-18 and the ppDDE level in LBP-1 exceeded their respective 50th percentile benchmarks. A resampling of BP-18 in 1997 indicated a mercury level of an order of magnitude lower than the 1996 level. The mean mercury concentration for all the sampled borrow areas falls between the 10th and 50th percentile benchmarks. BP-18 is located in the reach of the Mississippi River that USGS has reported to contain the highest dissolved mercury concentrations within the entire river. Therefore, the mercury level of the sediment sample collected from BP-18 does not represent mercury levels found in the sediment of other riverside borrow areas. While the 10th percentile benchmark was exceeded for other metals within several sampled areas, none exceeded the 50th percentile benchmark. The high level of ppDDE in LBP-1 is not surprising since this borrow area is located on the landside of the levee within a heavy agricultural area. The magnitude of ppDDE detected within this borrow area is similar to levels detected during other Vicksburg District studies in the Yazoo Basin. Concentrations of ppDDE of this magnitude and even greater were detected within some rivers and oxbow lakes within the intensely developed agricultural areas of the Mississippi Delta. Based on EPA studies, these high levels of DDE in fish from landside borrow areas could cause chronic reproductive problems in the fish and pose a health risk to human consumers. No pesticides were detected in greater than trace amounts within any of the riverside borrow areas.

DIRECT IMPACTS TO WATER QUALITY

No-Action Plan

26. There would be no impacts to water quality by the no-action plan.

Plan 1--Nonstructural

27. There would be no impacts to water quality by a nonstructural plan.

Plan 2--Landside Borrow

28. The major impact to water quality will be localized increases in turbidity and suspended solids due to the disturbance of the soils. These impacts will be localized to the area immediately adjacent to the borrow area, the haul roads, and the levee or berm item being constructed. Stormwater Prevention Plans will be filed with the appropriate state agency for each work item. These plans will outline the steps that will be taken to reduce nonpoint runoff from the construction site and thus, minimize the direct impacts to water quality. The levee and berms will be seeded as soon as construction is complete to ensure the long-term protection of water quality. The impacts to water quality will be short term, lasting only until shortly after construction is complete and the seeded areas are stabilized by the new grass. Water quality in landside borrow areas would likely be poor due to high nutrient loading and the high levels of organochlorine pesticides that would accumulate in the sediments and in fish tissues. The high levels of pesticides in fish tissues would constitute a health risk to human consumers and could cause chronic reproductive problems to the fish. Therefore, the landside borrow areas will either be isolated from local drainage and pond stormwater, or they will be connected to local drainage, sloped so that they do not permanently pond water, and reforested. The areas may be seeded with grass to provide immediate short-term soil retention.

Plan 3--Traditional Levee Construction with Riverside Borrow

29. As with the landside borrow option, the major impact to water quality will be localized increases in turbidity and suspended solids. The impacts will be greatest in the immediate construction areas. No work will be performed during high water periods when the borrow material is obtained riverside of the levees. Most riverside borrow areas will be dry during the construction period because the material is easier to handle when it is dry. Thus, the direct impacts to water quality will be minimized. Turbidity increases are likely during rain events that occur during the construction period. These impacts will be lessened by the application of best management practices for nonpoint pollution at construction sites. The Districts will file a Stormwater Prevention Plan with the appropriate state government prior to construction of any item.

Plan 4--Avoid and Minimize

30. The direct impacts from this option are localized increases in turbidity and suspended solids. The impacts have the potential of affecting somewhat larger areas due to longer haul distances, but reasonable efforts to reduce nonpoint pollution will be performed. The avoid-and-minimize option includes the construction of some berms by dredging the material from the Mississippi River. The existing berm will be degraded and used to raise the levees. Sand will then be

dredged from sandbars and placed in the excavated areas on the berms. The effluent water will be returned to the riverside of the levee. Because the dredged material is going to consist primarily of sand, the effluent return should be fairly clean. Sand generally drops out of suspension within 50 to 100 feet of the dredge pipe. The maximum anticipated suspended solids levels are 2,000 mg/L. This is based on samples with 5 percent silt and clay and is compared with containment areas having effluent solids levels of 10,000 to 20,000 mg/L when the silt and clay fraction is much higher. The dredge effluent return will range between 25 and 50 cubic feet per second (cfs) which will eventually mix with the Mississippi River. The minimum observed flow in the Mississippi River at Vicksburg is approximately 100,000 cfs. Thus, the effluent would be diluted a minimum of 2,000 times. A short turbidity plume may be visible in the vicinity of the effluent return, but this should mix within 1,000 feet of the point of return.

31. Another feature of this plan is the use of relief wells in some places to substitute for additional berms. The direct impact to water quality from the construction of relief wells will be very minimal. The construction sites will be small. There may be slight increases in suspended solids and turbidity levels during storm events. Considering the high ambient levels of turbidity from other nonpoint sources landside of the levees, no observable effects are expected. A Stormwater Prevention Plan will be filed with the appropriate state agency. In most cases, only a small site (100 feet by 100 feet) will be used. Large vegetation will be removed, but the site will not be scraped to the ground. This will minimize the soil disturbance at the site and reduce the potential for direct impacts from elevated levels of turbidity and suspended solids.

32. Finally, slurry trench cutoffs will also be used in some places instead of berms to prevent seepage under the levees. A cutoff is a deep trench filled with grout or other materials. Construction involves clearing the right-of-way, digging the trench with placement of the material to one side of the trench, and filling the trench with grout. The major impact to water quality will be elevated turbidity and suspended solids levels from the site disturbance and the dredged material bank. After the trench is filled, the dredged material bank will be dressed and seeded to reduce erosion from the site.

INDIRECT IMPACTS TO WATER QUALITY

No Action Plan

33. There will be no indirect impacts to water quality resulting from this plan.

Plan 1--Nonstructural

34. There will be no indirect impacts to water quality resulting from the implementation of a nonstructural plan.

Plan 2--Landside Borrow Areas

35. The net impact of this plan is that small areas of land would be removed from row crop production and either reforested or isolated. This would slightly reduce the overall input of nutrients and turbidity to the local environment. The magnitude would likely be immeasurable. With proper siting, a reforested area could become a sump for local runoff and intercept some materials before they reach the local drainage network. If a conventional pit was constructed on agricultural lands and not isolated from local runoff, the pit would become a sink for pesticides such as DDT and its derivatives. Most Delta streams have high levels of these pesticides in the

sediments. Recent studies by the Natural Resources Conservation Service and the Corps have shown that some fish still exceed the FDA action level for total DDT (5.0 mg/kg in fish tissue). This would expose the fish and human consumers to the effects of DDT and its breakdown products. As was described earlier, the levels of DDE that would accumulate in fish would likely adversely affect fish reproductive ability and would constitute a health risk to human consumers.

Plan 3--Traditional Riverside Borrow

36. The long-term impacts to water quality from riverside borrow areas are few. The areas act as sinks for nutrients and sediments. Some of the areas studied in the LMREP have since filled. In fact, five of the areas selected for sampling in 1997 had either transitioned into willow flats or were dry. The borrow areas that hold water in most years have been shown to be good fishery habitat. They perform many of the functions of wetlands, such as nutrient retention and cycling, trapping pollutants, and organic carbon processing. They do not export organic carbon, but trap it in their sediments. With the possible exception of mercury, they do not exhibit high levels of either organic or inorganic pollutants in the sediments or water. Although their small relative size and volume make it unlikely that they will have any measurable impact on the water quality of the Mississippi River, they are important aspects of the batture area habitat. They provide good habitat for fish and waterfowl and add diversity to the general environment.

Plan 4--Avoid and Minimize

37. Like the traditional riverside borrow areas described in the previous paragraph, this project plan will have little long-term impact on water quality in the Mississippi River and the batture environment. This plan differs from the previous plan in that cleared lands will be preferentially selected and some environmental features will be added to the areas to improve the long-term impact of the areas to the local environment. It is unlikely that reforested borrow areas will have a greater net impact on water quality over pits that fill with water. Both will perform the wetland functions described in the previous paragraph. The forested areas may be net exporters of organic carbon instead of organic carbon sinks. Although the borrow areas holding water may trap some organic carbon, the amount will not significantly alter the organic carbon levels in the Mississippi River. Environmental features such as reforesting the areas around the pits will enhance the localized value of the sites and improve such functions as sediment and nutrient retention, but again due to their small total area and volume, it will not measurably change nutrient or suspended solids levels in the Mississippi River. Reforesting around the borrow areas will likely have a long-term impact on water temperature within the borrow areas and may reduce the suspended solids loads that the individual pits receive.

CONCLUSION

38. Water quality in the Mississippi River is basically good. The waters are within expected ranges most of the time. Water quality in existing borrow areas is good to excellent, and new pits if constructed riverside of the levees are expected to have good water quality. Landside pits have the potential to trap high levels of chlorinated pesticides, which could threaten the health of fish populations and their potential consumers. Construction of the Mississippi River levees and its associated features may have some short-term direct impacts on water quality which would be localized to the vicinity around the project. There are no short- or long-term impacts expected to the water quality of the Mississippi River. Although the project may induce some sediment and nutrient retention, this retention will be small in scale and will not affect the hypoxia zone in the Gulf of Mexico.

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Table 17-1
Water Quality Sampling Locations

Location	River Mile	District	Parish / County	State
Island No 8	910-R	Memphis	New Madrid	Missouri
Chisholm Lake	804-L	Memphis	Lauderdale	Tennessee
BP-17	773-R	Memphis	Mississippi	Arkansas
Brandywine	748-R	Memphis	Crittenden	Arkansas
Tunica Lake	677-L	Memphis	Tunica	Mississippi
BP-15	659-L	Memphis	Coahoma	Mississippi
BP-13	656-R	Memphis	Phillips	Arkansas
BP-9	595-L	Vicksburg	Bolivar	Mississippi
BP-8	593-L	Vicksburg	Bolivar	Mississippi
Lake Whittington	576-L	Vicksburg	Bolivar	Mississippi
LPit-1	495-R	Vicksburg	East Carroll	Louisiana
LPit-2	493-R	Vicksburg	East Carroll	Louisiana
LPit-3	492-R	Vicksburg	East Carroll	Louisiana
LPit-4	491-R	Vicksburg	East Carroll	Louisiana
BP-4	482-R	Vicksburg	East Carroll	Louisiana
BP-3	469-R	Vicksburg	East Carroll	Louisiana
LBP-1	467-R	Vicksburg	East Carroll	Louisiana
BP-5	462-R	Vicksburg	East Carroll	Louisiana
BP-7	460-L	Vicksburg	Warren	Mississippi
BP-10	456-R	Vicksburg	Madison	Louisiana
BP-6	433-R	Vicksburg	Madison	Louisiana
BP-1	431-R	Vicksburg	Madison	Louisiana
Palmyra Lake	420-R	Vicksburg	Tensas / Madison	Louisiana
Yucatan Lake	408-R	Vicksburg	Tensas	Louisiana
BP-2	407-R	Vicksburg	Tensas	Louisiana
BP-12	377-R	Vicksburg	Concordia / Tensas	Louisiana
BP-18	323-R	Vicksburg	Concordia	Louisiana
Lake Mary	323-L	Vicksburg	Wilkinson	Mississippi
Raccourci	290-R	New Orleans	West Feliciana / Pointe Coupee	Louisiana
Bayou Goula	194-R	New Orleans	Iberville	Louisiana
BP-25	180-L	New Orleans	Ascension	Louisiana

Table 17-2A
Mississippi River at Memphis, TN

Historic Water Quality Data					
Water Quality Parameters	#Obs	10% / 25%	Mean / Median	90% / 75%	Criteria
Temperature (Degrees Celcius)	171	5	18.9	29	32 Deg C (max) LA & MS
		10	20.0	29	
pH (Standard Units)	173	7.5	7.86	8.2	6.5-9.0 MS 6.0-9.0 LA
		7.69	7.9	8.1	
Dissolved Oxygen (mg/l)	140	6.2	8.48	11.7	5.0 (min) MS & LA
		7.0	8.3	9.3	
Alkalinity (mg/l)	89	79	102	129	
		92	106	112	
Conductivity (umhos/cm)	173	310	414	548	1000 MS
		358	415	460	
Turbidity (NTU)	42	20	69	120	150 LA for Miss. River
		28	56	80	
Total Suspended Solids (mg/l)	141	67	166	312	
		87	133	192	
Total Dissolved Solids (mg/l)	140	191	236	288	750 (avg) MS 400-425 MS for Miss. River
		209	235	264	
Total Organic Carbon (mg/l)	42	5.8	8.7	14.0	
		6.3	7.2	8.9	
Total Phosphorus (mg/l P)	141	0.12	0.22	0.34	0.3 MS
		0.16	0.20	0.25	
Total Dissolved Phosphorus (mg/l P)	100	0.05	0.087	0.12	0.3 MS
		0.06	0.07	0.095	
Total Kjeldahl Nitrogen (mg/l N)	136	0.50	0.96	1.60	1.0 MS
		0.65	0.88	1.10	
Total Nitrate Nitrogen (mg/l N)	95	0.68	1.37	2.10	1.0 MS
		0.95	1.30	1.70	
Ammonia Nitrogen (mg/l N)	73	0.01	0.075	0.18	
		0.03	0.05	0.09	
Sulfate (mg/l)	141	41	58	82	120-150 MS for Miss. River
		47	55	67	

#Obs = Number of Observations
Shaded values do not meet applicable criteria
MS = Mississippi Department of Environmental Quality criteria or benchmark levels
LA = Louisiana Department of Environmental Quality criteria

Table 17-2A (cont)
Mississippi River at Memphis, TN

Historic Water Quality Data										
Dissolved Trace Metals (ug/l)										
Parameter	**Time or Type**	**#Dets / #Obs**	**Mean of Dets**	**Mean of Obs**	**10%**	**25%**	**50%**	**75%**	**90%**	**Criteria**
Arsenic	<1/1/87	44 / 49	1.80	1.66	0.5	1	1	2	3	360 FWA 190 FWC
	>1/1/87	12 / 19	1.50	1.13	0.5	0.5	1	2	2	
Cadmium	<1/1/87	9 / 49	**22.56**	**4.63**	0	0.5	0.5	1	**2**	5.7 FWA 1.5 FWC
	>1/1/87	4 / 19	**4.00**	1.24	0.5	0.5	0.5	0.5	**4**	
Chromium	<1/1/87	20 / 49	6.15	2.79	0	0	0	3	10	2287 FWA 273 FWC
	>1/1/87	0 / 19	NA	0.61	0.5	0.5	0.5	0.5	0.5	
Copper	<1/1/87	47 / 49	10.96	10.92	3	5	9	14	**25**	24.3 FWA 15.8 FWC
	>1/1/87	18 / 19	8.28	8.11	2	3	7	10	**16**	
Lead	<1/1/87	30 / 49	2.90	1.96	0	0	1	3	**5**	125 FWA 4.9 FWC
	>1/1/87	2 / 19	1.00	2.05	0.5	1	2.5	2.5	2.5	
Mercury	<1/1/87	16 / 48	**0.13**	**0.14**	0	**0.05**	**0.1**	**0.25**	**0.25**	2.4 FWA 0.012 FWC
	>1/1/87	2 / 19	**0.15**	**0.06**	**0.05**	**0.05**	**0.05**	**0.05**	**0.1**	
Nickel	<1/1/87	25 / 27	4.08	3.81	0.5	2	3	6	7	2382 FWA 123 FWC
	>1/1/87	27 / 31	4.00	3.69	1	2	2	4	6	
Selenium	<1/1/87	22 / 49	1.36	0.89	0	0.5	0.5	1	2	260 FWA 35 FWC
	>1/1/87	3 / 31	1.00	0.55	0.5	0.5	0.5	0.5	0.5	
Silver	<1/1/87	8 / 34	0.25	0.34	0	0	0.5	0.5	0.5	7.2 FWA
	>1/1/87	4 / 31	3.25	0.85	0.5	0.5	0.5	0.5	1	
Zinc	<1/1/87	37 / 49	59.03	46.26	4	10	12	40	**150**	156 FWA 141 FWC
	>1/1/87	17 / 19	16.35	14.79	1.5	6	9	17	43	
Chlorinated Pesticides (ug/l)										
DDD	Total	0 / 19	0	0.00053	0	0	0	0	0.005	0.05 FWA
DDE	Total	0 / 19	0	0.00053	0	0	0	0	0.005	1050 FWA
DDT	Total	0 / 19	0	0.00053	0	0	0	0	0.005	1.10 FWA 0.001 FWC
Dieldrin	Total	1 / 19	**0.01**	0.00079	0	0	0	0	0.005	2.5 FWA 0.0019 FWC
Endrin	Total	0 / 19	0	0.00053	0	0	0	0	0.005	0.08 FWA 0.0023 FWC
Heptachlor	Total	0 / 19	0	0.00053	0	0	0	0	0.005	0.52 FWA 0.0038 FWC
Toxaphene	Total	0 / 19	0	0.00053	0	0	0	0	0.005	0.73 FWA 0.0002 FWC

<1/1/87 = samples collected prior to 1/1/1987
>1/1/87 = samples collected since 1/1/1987
#Dets = Number of Detections
#Obs = Number of Observations
FWA = Fresh Water Acute criteria
FWC = Fresh Water Chronic criteria
Bold values exceed the FWC
Bold and Shaded values exceed the FWA

Table 17-2B
Mississippi River at Vicksburg, MS

Historic Water Quality Data					
Water Quality Parameters	#Obs	10% / 25%	Mean / Median	90% / 75%	Criteria
Temperature (Degrees Celsius)	116	5	15.9	28	32 Deg C (max) MS & LA
		7.5	15	24.5	
pH (Standard Units)	119	7.3	7.7	8.1	6.5-9.0 MS 6.0-9.0 LA
		7.5	7.8	7.9	
Dissolved Oxygen (mg/l)	109	6.6	8.85	11.6	5.0 (min) MS & LA
		7.2	8.4	10.2	
Alkalinity (mg/l)	73	88	99.5	125	
		73	98	114	
Conductivity (umhos/cm)	120	277.5	364.8	441.5	1000 MS
		315.5	370	416	
Turbidity (NTU)	79	5	58.4	130	150 LA for Miss. River
		27	55	85	
Total Suspended Solids (mg/l)	107	100	268	486	
		166	244	338	
Total Dissolved Solids (mg/l)	117	170	222.6	270	750 (Avg) MS 400-425 MS for Miss. River
		196	222	250	
Total Organic Carbon (mg/l)	35	3.7	6.5	10	
		4.4	6.0	8.1	
Total Phosphorus (mg/l P)	108	0.11	0.20	0.32	0.3 MS
		0.14	0.19	0.23	
Total Dissolved Phosphorus (mg/l P)	79	0.05	0.07	0.09	0.3 MS
		0.05	0.06	0.08	
Total Kjeldahl Nitrogen (mg/l N)	105	0.42	0.76	1.1	1.0 MS
		0.6	0.7	0.94	
Total Nitrate Nitrogen (mg/l N)	74	0.68	1.23	1.9	1.0 MS
		0.96	1.15	1.5	
Ammonia Nitrogen (mg/l N)	64	0.01	0.05	0.13	
		0.02	0.04	0.07	
Sulfate (mg/l)	117	35	48.3	65	120-150 MS for Miss. River
		40	46	55	

#Obs = Number of Observations
Shaded values do not meet applicable criteria
MS = Mississippi Department of Environmental Quality benchmark levels
LA = Louisiana Department of Environmental Quality benchmark levels

Table 17-2B (cont)
Mississippi River at Vicksburg, MS

Historic Water Quality Data										
Dissolved Trace Metals (ug/l)										
Parameters	**Time or Type**	**#Dets / #Obs**	**Mean of Dets**	**Mean of Obs**	**10%**	**25%**	**50%**	**75%**	**90%**	**Criteria**
Arsenic	<1/1/87	33 / 39	2.21	1.95	0.5	1	1	2	6	360 FWA 190 FWC
	>1/1/87	14 / 17	1.36	1.21	0.5	1	1	2	2	
Cadmium	<1/1/87	16 / 39	5.00	2.31	0	0	1	**2**	**4**	5.7 FWA 1.5 FWC
	>1/1/87	5 / 17	2.20	1.00	0.5	0.5	0.5	1	**2**	
Chromium	<1/1/87	11 / 36	7.91	3.81	0	0	1	9	10	2287 FWA 273 FWC
	>1/1/87	2 / 17	1.00	0.56	0.5	0.5	0.5	0.5	1	
Copper	<1/1/87	36 / 39	4.89	4.51	0	2	3	6	8	24.3 FWA 15.8 FWC
	>1/1/87	14 / 16	3.78	3.66	1	2	3	5	6	
Lead	<1/1/87	32 / 39	5.56	4.73	0	1	3	**5**	**13**	125 FWA 4.9 FWC
	>1/1/87	2 / 17	1.00	1.88	0.5	0.5	2.5	2.5	2.5	
Mercury	<1/1/87	10 / 35	**0.33**	**0.23**	**0.05**	**0.1**	**0.25**	**0.25**	**0.3**	2.4 FWA 0.012 FWC
	>1/1/87	4 / 17	**0.35**	**0.12**	**0.05**	**0.01**	**0.05**	**0.05**	**0.3**	
Nickel	<1/1/87	17 / 17	2.88	2.88	1	1	2	4	6	2382 FWA 123 FWC
	>1/1/87	28 / 28	2.93	2.93	1	2	2	3	6	
Selenium	<1/1/87	19 / 36	1.79	1.18	0	0.5	0.5	1	3	260 FWA 35 FWC
	>1/1/87	2 / 29	1.00	0.53	0.5	0.5	0.5	0.5	0.5	
Silver	<1/1/87	6 / 22	0.50	0.36	0	0	0.25	0.5	0.5	7.2 FWA
	>1/1/87	3 / 29	1.33	0.59	0.5	0.5	0.5	0.5	1	
Zinc	<1/1/87	25 / 39	22.12	16.42	2	6	10	20	30	156 FWA 141 FWC
	>1/1/87	16 / 17	30.38	28.68	3	7	12	18	49	
Chlorinated Pesticides (ug/l)										
DDD	Total	0 / 4	0	0	0	0	0	0	0	0.05 FWA
DDE	Total	0 / 4	0	0	0	0	0	0	0	1050 FWA
DDT	Total	0 / 4	0	0	0	0	0	0	0	1.10 FWA 0.001 FWC
Dieldrin	Total	0 / 4	0	0	0	0	0	0	0	2.5 FWA 0.0019 FWC
Endrin	Total	0 / 4	0	0	0	0	0	0	0	0.08 FWA 0.0023 FWC
Heptachlor	Total	0 / 4	0	0	0	0	0	0	0	0.52 FWA 0.0038 FWC
Toxaphene	Total	0 / 4	0	0	0	0	0	0	0	0.73 FWA 0.0002 FWC

<1/1/87 = samples collected prior to 1/1/1987 >1/1/87 = samples collected since 1/1/1987
#Dets = Number of Detections #Obs = Number of Observations
FWA = Fresh Water Acute criteria FWC = Fresh Water Chronic criteria
Bold values exceed the FWC Bold and Shaded values exceed the FWA

Table 17-2C
Mississippi River at New Orleans, LA

Historic Water Quality Data					
Water Quality Parameters	#Obs	10% / 25%	Mean / Median	90% / 75%	Criteria
Temperature (Degrees Celcius)	326	7	18.2	29.5	32 Deg C (max) LA & MS
		10.5	18	27	
pH (Standard Units)	631	7.2	7.5	7.9	6.5-9.0 MS 6.0-9.0 LA
		7.3	7.6	7.8	
Dissolved Oxygen (mg/l)	304	6.2	8.5	11.2	5.0 (min) MS & LA
		6.9	8.2	10.0	
Alkalinity (mg/l)	640	77.5	104	131	
		89	103	119	
Conductivity (umhos/cm)	640	297	396	499	1000 MS
		335	398	451	
Turbidity (NTU)	71	20	56.1	90	150 LA for Miss. River
		30	55	75	
Total Suspended Solids (mg/l)	NA				
Total Dissolved Solids (mg/l)	817	187	244	302	750 (avg) MS 400-425 MS for Miss. River
		211	243	278	
Total Organic Carbon (mg/l)	240	3.7	6.5	10.0	
		4.5	5.8	7.3	
Total Phosphorus (mg/l P)	240	0.13	0.258	0.40	0.3 MS
		0.175	0.24	0.32	
Total Dissolved Phosphorus (mg/l P)	16	0.04	0.076	0.11	0.3 MS
		0.06	0.08	0.10	
Total Kjeldahl Nitrogen (mg/l N)	35	0.49	0.77	1.1	1.0 MS
		0.57	0.70	0.87	
Total Nitrate Nitrogen (mg/l N)	226	0.70	1.38	2.1	1.0 MS
		1.0	1.3	1.7	
Ammonia Nitrogen (mg/l N)	29	0.01	0.035	0.08	
		0.02	0.03	0.04	
Sulfate (mg/l)	632	36	52	71	120 -150 MS for Miss. River
		42	50	61	

#Obs = Number of Observations
Shaded values do not meet applicable criteria
MS = Mississippi Department of Environmental Quality criteria or benchmark levels
LA = Louisiana Department of Environmental Quality criteria

Table 17-2C (cont)
Mississippi River at New Orleans, LA

Historic Water Quality Data										
Dissolved Trace Metals (ug/l)										
Parameters	**Time or Type**	**#Dets / #Obs**	**Mean of Dets**	**Mean of Obs**	**10%**	**25%**	**50%**	**75%**	**90%**	**Criteria**
Arsenic	<1/1/87	174 / 222	2.20	1.83	0.5	1	1	2	3	360 FWA 190 FWC
	>1/1/87	40 / 65	1.40	1.05	0.5	0.5	1	1	2	
Cadmium	<1/1/87	49 / 222	**2.31**	0.75	0	0	0.5	1	**2**	5.7 FWA 1.5 FWC
	>1/1/87	6 / 65	**2.17**	0.65	0.5	.05	0.5	0.5	0.5	
Chromium	<1/1/87	1 / 2	10.00	7.5	5	5	7.5	10	10	2287 FWA 273 FWC
	>1/1/87	0 / 0	NA	NA	NA	NA	NA	NA	NA	
Copper	<1/1/87	122 / 126	6.07	6.04	3	4	6	7	11	24.3 FWA 15.8 FWC
	>1/1/87	63 / 64	4.67	4.59	3	3.5	4	5	7	
Lead	<1/1/87	94 / 221	3.47	1.90	0	0	1	2.5	**5**	125 FWA 4.9 FWC
	>1/1/87	1 / 65	1.00	1.43	0.5	0.5	0.5	2.5	2.5	
Mercury	<1/1/87	48 / 141	**0.11**	**0.116**	0	**0.05**	**0.05**	**0.25**	**0.25**	2.4 FWA 0.012 FWC
	>1/1/87	9 / 67	**0.13**	**0.061**	**0.05**	**0.05**	**0.05**	**0.05**	**0.1**	
Nickel	<1/1/87	99 / 117	3.44	2.09	0.5	1	3	4	6	2382 FWA 123 FWC
	>1/1/87	51 / 65	2.43	2.01	0.5	1	2	3	4	
Selenium	<1/1/87	40 / 116	0.48	0.49	0	0.5	0.5	0.5	1	260 FWA 35 FWC
	>1/1/87	0 / 65	NA	0.5	.05	0.5	0.5	0.5	0.5	
Silver	<1/1/87	1 / 2	2.00	1.25	0.5	0.5	1.25	2	2	7.2 FWA
	>1/1/87	0 / 0	NA	NA	NA	NA	NA	NA	NA	
Zinc	<1/1/87	135 / 222	19.53	13.99	0	6	10	17	25	156 FWA 141 FWC
	>1/1/87	29 / 65	12.86	8.23	2.5	5	5	10	20	
Chlorinated Pesticides (ug/l)										
DDD	Total	0 / 5	0	0.0041	0.0005	0.005	0.005	0.005	0.005	0.05 FWA
DDE	Total	0 / 5	0	0.0041	0.0005	0.005	0.005	0.005	0.005	1050 FWA
DDT	Total	0 / 5	0	**0.0041**	0.0005	**0.005**	**0.005**	**0.005**	**0.005**	1.10 FWA 0.001 FWC
Dieldrin	Total	0 / 5	0	**0.0041**	0.0005	**0.005**	**0.005**	**0.005**	**0.005**	2.5 FWA 0.0019 FWC
Endrin	Total	0 / 5	0	**0.0041**	0.0005	**0.005**	**0.005**	**0.005**	**0.005**	0.08 FWA 0.0023 FWC
Heptachlor	Total	0 / 5	0	**0.0041**	0.0005	**0.005**	**0.005**	**0.005**	**0.005**	0.52 FWA 0.0038 FWC
Toxaphene	Total	0 / 5	0	**0.4**	**0.25**	**0.25**	**0.5**	**0.5**	**0.5**	0.73 FWA 0.0002 FWC

<1/1/87 = samples collected prior to 1/1/1987
>1/1/87 = samples collected since 1/1/1987
#Dets = number of detections
#Obs = Number of Observations
FWA = Fresh Water Acute criteria
FWC = Fresh Water Chronic criteria
Bold and Shaded values exceed the FWA
Bold values exceed the FWC
NA = Not Applicable

Table 17-2D
Mississippi River at Venice, LA

Historic Water Quality Data					
Water Quality Parameters	#Obs	10%	Mean	90%	Criteria
		25%	Median	75%	
Temperature (Degrees Celcius)	305	8	18.7	29.5	32 Deg C (max) LA & MS
		11	18.5	27	
pH (Standard Units)	303	7.2	7.6	8.0	6.5-9.0 MS 6.0-9.0 LA
		7.4	7.6	7.8	
Dissolved Oxygen (mg/l)	307	6.1	8.3	11.0	5.0 (min) MS & LA
		6.6	8.1	9.6	
Alkalinity (mg/l)	307	82	105	131	
		91	104	118	
Conductivity (umhos/cm)	312	310	661	1350	1000 MS
		342	407	515	
Turbidity (NTU)	72	8	45.3	85	150 LA for Miss. River
		15	35.0	65	
Total Suspended Solids (mg/l)	6	126	296	708	
		142	237	327	
Total Dissolved Solids (mg/l)	83	189	262	330	750 (avg) MS 400-425 MS for Miss. River
		208	228	274	
Total Organic Carbon (mg/l)	237	3.5	5.8	8.8	
		4.1	5.4	6.9	
Total Phosphorus (mg/l P)	241	0.12	0.30	0.36	0.3 MS
		0.16	0.21	0.28	
Total Dissolved Phosphorus (mg/l P)	17	0.04	0.082	0.13	0.3 MS
		0.06	0.080	0.10	
Total Kjeldahl Nitrogen (mg/l N)	36	0.30	0.64	1.10	1.0 MS
		0.40	0.59	0.82	
Total Nitrate Nitrogen (mg/l N)	230	0.72	1.37	2.1	1.0 MS
		1.0	1.30	1.7	
Ammonia Nitrogen (mg/l N)	32	0.01	0.029	0.07	
		0.015	0.020	0.035	
Sulfate (mg/l)	304	36	62.2	100	120-150 MS for Miss. River
		41	50.0	62.5	

#Obs = Number of Observations
Shaded values do not meet applicable criteria
MS = Mississippi Department of Environmental Quality criteria or benchmark levels
LA = Louisiana Department of Environmental Quality criteria

Table 17-2D (cont)
Mississippi River at Venice, LA

Historic Water Quality Data										
Dissolved Trace Metals (ug/l)										
Parameters	Time or Type	#Dets / #Obs	Mean of Dets	Mean of Obs	10%	25%	50%	75%	90%	Criteria
Arsenic	<1/1/87	169 / 221	2.06	1.69	0.5	1	1	2	3	360 FWA 190 FWC
	>1/1/87	38 / 64	1.45	1.06	0.5	0.5	1	1.5	2	
Cadmium	<1/1/87	52 / 220	**2.27**	0.77	0	0	0.5	1	**2**	5.7 FWA 1.5 FWC
	>1/1/87	8 / 64	1.50	0.63	0.5	0.5	0.5	0.5	1	
Chromium	<1/1/87	2 / 3	10.00	8.33	5	5	10	10	10	2287 FWA 273 FWC
	>1/1/87	0 / 0	NA	NA	NA	NA	NA	NA	NA	
Copper	<1/1/87	121 / 127	5.62	5.49	2	3	5	7	10	24.3 FWA 15.8 FWC
	>1/1/87	64 / 64	4.33	4.33	2	3	4	5	7	
Lead	<1/1/87	102 / 218	3.37	1.94	0	0	1	3	4	125 FWA 4.9 FWC
	>1/1/87	1 / 64	1.00	1.41	0.5	0.5	0.5	2.5	2.5	
Mercury	<1/1/87	36 / 139	**0.13**	**0.117**	0	**0.05**	**0.05**	**0.25**	**0.25**	2.4 FWA 0.012 FWC
	>1/1/87	9 / 65	**0.12**	**0.060**	**0.05**	**0.05**	**0.05**	**0.05**	**0.1**	
Nickel	<1/1/87	105 / 126	3.21	2.71	0	1	2	4	5	2382 FWA 123 FWC
	>1/1/87	55 / 64	2.38	2.12	0.5	1	2	3	4	
Selenium	<1/1/87	39 / 116	0.59	0.53	0	0.5	0.5	0.5	1	260 FWA 35 FWC
	>1/1/87	0 / 64	NA	0.50	0.5	0.5	0.5	0.5	0.5	
Silver	<1/1/87	0 / 3	NA	0.50	0.5	0.5	0.5	0.5	0.5	7.2 FWA
	>1/1/87	0 / 0	NA	NA	NA	NA	NA	NA	NA	
Zinc	<1/1/87	148 / 220	15.95	12.75	0	6.5	10	20	20.5	156 FWA 141 FWC
	>1/1/87	33 / 64	13.91	9.27	2.5	5	5	10	20	
Chlorinated Pesticides (ug/l)										
DDD	Total	0 / 4	0	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.05 FWA
DDE	Total	0 / 4	0	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	1050 FWA
DDT	Total	1 / 4	**0.003**	**0.0011**	0.0005	0.0005	0.0005	**0.0018**	**0.003**	1.10 FWA 0.001 FWC
Dieldrin	Total	0 / 4	0	0.0004	0	0.0003	0.0005	0.0005	0.0005	2.5 FWA 0.0019 FWC
Endrin	Total	1 / 4	**0.008**	0.0024	0.0005	0.0005	0.0005	**0.0043**	**0.008**	0.08 FWA 0.0023 FWC
Heptachlor	Total	0 / 4	0	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.52 FWA 0.0038 FWC
Toxaphene	Total	0 / 4	0	**0.163**	**0.05**	**0.05**	**0.05**	**0.275**	**0.5**	0.73 FWA 0.0002 FWC

<1/1/87 = samples collected prior to 1/1/1987
>1/1/87 = samples collected since 1/1/1987
#Det = number of detections

#Obs = Number of Observations
FWA = Fresh Water Acute criteria
FWC = Fresh Water Chronic criteria

Bold and Shaded values exceed the FWA
Bold values exceed the FWC
NA = Not Applicable

Table 17-3
Analysis of Mississippi River Water For Designated Uses By State

Use	Supporting	Threatened	Partially Supporting	Not Supporting
Illinois				
Aquatic Life			Moderate	
Fish Consumption				Sturgeon
Swimming	Not Assessed			
Drinking Water	Not Assessed			
Kentucky				
Aquatic Life	218.4 miles	1.7 miles	11.9 miles	7.0 miles
Fish Consumption	5.3 miles	0 miles	0 miles	0 miles
Swimming	35.4 miles	0 miles	11.9 miles	0 miles
Drinking Water	0 miles	0 miles	0 miles	0 miles
Missouri				
Aquatic Life			X - due to hydrologic modification	
Fish Consumption			X - limited to 1 lb / week of bottom feeders due to chlordane	
Swimming	X			
Drinking Water	X			
Tennessee				
Overall			157 miles	27 miles due to presence of chlordane

Table 17-3 (cont)
Analysis of Mississippi River Water For Designated Uses By State

Use	Supporting	Threatened	Partially Supporting	Not Supporting
Arkansas				
Aquatic Life			38.9 miles	
Fish Consumption	38.9 miles			
Swimming				38.9 miles
Drinking Water	38.9 miles			
Mississippi				
Aquatic Life			1 station	
Fish Consumption	1 station	2 stations		
Primary Contact Recreation				
Secondary Contact Recreation			1 station	
Louisiana				
Overall	369 miles		344 miles	
Primary Contact Recreation	315 miles	54 miles		344 miles
Secondary Contact Recreation	315 miles	54 miles		344 miles
Fish and Wildlife Propagation	454 miles	259 miles		

The State of Arkansas has assessed 38.9 miles out of a total of 437 miles.

The assessment of the Mississippi River within the State of Mississippi is based on 4 stations.

All data contained within this table were obtained directly from the 305(b) Water Quality Reports as prepared by each state.

Table 17-4
Analyzed Water Quality Parameters

In Situ Parameters	Physico-Chemical Parameters
Temperature	Turbidity
Dissolved Oxygen	Total Solids (TS)
pH	Total Suspended Solids (TSS)
Specific Conductance	Total Kjeldahl Nitrogen (TKN)
Non-Priority Pollutant Metals	Total Phosphorous
Barium	Orthophosphate
Cobalt	Total Organic Carbon
Iron	Sulfate
Manganese	

Priority Pollutants	
Metals	**Pesticides**
Arsenic	Aldrin
Cadmium	Alpha-BHC
Chromium	Beta-BHC
Copper	Delta-BHC
Lead	Gamma-BHC
Mercury	ppDDD
Nickel	ppDDE
Selenium	ppDDT
Zinc	Heptachlor
Antimony	Dieldrin
Beryllium	A-Endosulfan
Silver	B-Endosulfan
Thallium	Endosulfan Sulfate
PCBs	Endrin
PCB-1016	Endrin Aldehyde
PCB-1221	Heptachlor Epoxide
PCB-1232	Methoxychlor
PCB-1242	Chlordane
PCB-1248	Toxaphene
PCB-1254	
PCB-1260	

Other Priority Pollutants	
Phenol	Bis (2-Ethylhexyl) Phthalate
2-Chlorophenol	Di-N-Octylphthalate
2-Nitrophenol	Benzo (a) Anthracene
2,4-Dimethylphenol	Benzo (b) Fluoranthene
2,4-Dichlorophenol	Benzo (k) Fluoranthene
4-Chlor-3-Methylphenol	Benzo (a) Pyrene
2,4,6-Trichlorophenol	Indeno (1,2,3-C,D) Pyrene
2,4-Dinitrophenol	Dibenzo (A,H) Anthracene
4-Nitrophenol	Benzo (G,H,I) Perylene
2-Methyl-4,6-Dinotrophenol	Aniline
Pentachlorophenol	4-Chloroaniline
Benzoic Acid	Dibenzofuran

Table 17-4 (cont)
Analyzed Water Quality Parameters

Other Priority Pollutants	
2-Methylphenol	2-Methylnaphthalene
4-Methylphenol	2-Nitroaniline
2,4,5-Trichlorophenol	3-Nitroaniline
Benzyl Alcohol	4-Nitroaniline
N-Nitrosodimethylamine	Chloromethane
Bis(2-Chloroisopropyl) Ether	Bromomethane
N-Nitroso-Di-N-Propylamine	Vinyl Chloride
Nitrobenzene	Chloroethane
Isophorone	Methylene Chloride
Bis(2-Chloroethoxy) Methane	1,1-Dichloroethene
2,6-Dinitrotoluene	1,1-Dichloroethene
2,4-Dinitrotoluene	Trans-1,2-Dichloroethene
Benzidine	cis-1,2-Dichloroethene
3,3'Dichlorobenzidine	Chloroform
Bis (1-Chloroethly) Ether	1,2-Dichloroethane
1,3-Dichlorobenzene	1,1,1-Trichloroethane
1,4-Dichlorobenzene	Carbon Tetrachloride
1,2-Dichlorobenzene	Bromodichloromethane
Hexachloroethane	1,2-Dichloropropane
1,2,4-Trichlorobenzene	Trans-1,3-Dichloropropene
Naphthalene	Trichloroethene
Hexachlorobutadiene	Dibromochloromethane
Hexachlorocyclopentadiene	Cis-1,3-Dichloropropene
2-Chloronaphthalene	1,1,2-Trichloroethane
Acenaphthylene	Benzene
Dimethyl Phthalate	Bromoform
Acenaphthene	1,1,2,2-Tetrachloroethane
Fluorene	Tetrachloroethene
Diethyl Phthalate	Toluene
4-Chlorophenyl Phenyl Ether	Chlorobenzene
N-Nitrosodiphenyl Amine	Ethylbenzene
4-Bromophenyl Ehter	Acetone
Hexachlorobenzene	2-Butanone
Phenanthrene	Carbondisulfide
Anthracene	2-Hexanone
Dibutylphthalate	4-Methyl-2-Petanone
Fluoranthene	Styrene
Pyrene	Vinyl Acetate
Butylbenzylphthalate	T-Xylene
Chrysene	

Table 17-5
General Water Quality Data

Pit No.	Depth (meters)	Temp (Deg C)	pH	DO (mg/l)	Conductivity (umhos/cm)	Turbidity (NTU)
BP-17	Surface	24.1	7.5	3.6	205	26.6
	0.76	24.1	7.5	3.5	205	
	Mean	24.1	7.5	3.55	205	
BP-15	Surface	37.9	8.4	8.2	228	33.4
	.91	36.1	8.0	6.5	235	
	Mean	37.0	8.2	7.35	231.5	
BP-13	Surface	35.3	8.0	7.3	269	7.2
	1.22	32.0	7.6	4.5	272	
	3.35	27.9	7.0	0.3	303	
	Mean	31.7	7.5	4.0	281.3	
PB-9	Surface	19.3	7.4	7.6	284	18.9
	1.0	18.5	7.0	5.4	285	29.8
	2.0	18.0	6.7	3.0	287	
	3.0	17.4	6.6	0.0	289	
	Mean	18.3	6.9	4.0	286.3	24.4
BP-8	Surface	19.8	7.0	7.3	303	58.6
	1.0	18.8	7.0	6.9	278	61.7
	2.0	18.8	7.0	5.5	280	
	Mean	19.1	7.0	6.6	287	60.2
LPit-1	Surface	28.0	7.9	7.9	228	18.7
	1.83	27.0	7.7	7.4	230	
	3.66	26.5	7.2	0.6	236	
	Mean	27.2	7.6	5.3	231.3	
LPit-2	Surface	29.5	8.4	8.3	202	30.5
	0.91	28.3	7.9	8.4	210	
	1.52	27.0	8.3	7.2	204	
	Mean	28.3	8.2	8.0	205.3	
LPit-3	Surface	31.0	8.6	8.5	139	12.4
	1.22	26.6	8.6	7.9	138	
	2.44	26.3	8.0	3.3	141	
	Mean	28.0	8.4	6.6	139.3	
LPit-4	Surface	32.2	8.6	9.1	168	132.0
	0.91	25.5	8.3	6.2	172	
	2.13	25.5	8.1	5.1	172	
	Mean	27.7	8.3	6.8	170	

Table 17-5 (cont)
General Water Quality Data

Pit No.	Depth (meter)	Temp (Deg C)	pH	Do (mg/l)	Conductivity (umhos/cm)	Turbidity (NTU)
BP-4	Surface	19.9	7.67	12.4	286	21
	1.0	18.9	7.29	9.7	287	
	2.0	18.3	7.0	8.2	288	45
	3.0	18.3	7.06	2.0	288	
	Mean	18.82	7.3	8.1	287.3	33
BP-3	Surface	21.9	7.93	12.3	306	15
	1.0	20.9	7.5	10.5	301	30
	2.0	20.8	7.39	9.9	301	
	Mean	21.2	7.6	10.9	302.7	22.5
LBP-1	Surface	28.4	8.3	9.0	184	18.8
	1.0	27.2	7.6	5.0	190	
	2.0	26.0	6.9	0.1	230	22.5
	Mean	27.2	7.6	4.7	192.3	20.7
BP-5	Surface	20.5	7.3	8.7	287	37
	1.0	18.7	7.15	8.4	286	35
	2.0	18.5	7.09	8.42	287	
	Mean	19.2	7.2	8.5	286.7	36
BP-7	Surface	26.1	7.17	7.41	265	7.55
	1.0	22.4	6.99	3.25	263	7.5
	2.0	19.9	6.76	2.7	266	
	3.0	19.4	6.73	1.5	267	
	Mean	22.0	6.9	3.7	265.3	7.53
BP-10	Surface	19.3	7.44	9.7	285	16
	1.0	18.4	7.25	9.08	284	
	2.0	17.8	7.09	8.4	280	42
	3.0	17.4	6.88	4.5	287	
	Mean	18.2	7.2	7.9	284	29
BP-6	Surface	25.7	7.8	12.5	288	7.4
	1.0	24.6	7.7	11.5	287	6.8
	2.0	24.4	6.8	4.6	289	
	Mean	24.9	7.4	9.5	288	7.1
BP-1	Surface	21.6	7.3	8.7	290	23.4
	1.0	21.4	7.2	8.2	290	24
	2.0	20.1	7.0	7.3	290	
	3.0	19.9	6.95	7.0	290	
	Mean	20.75	7.1	7.8	290	23.7

Table 17-5 (cont)
General Water Quality Data

Pit No.	Depth (meter)	Temp (Deg C)	pH	Do (mg/l)	Conductivity (umhos/cm)	Turbidity (NTU)
BP-2	Surface	23.7	7.63	10.3	335	14
	1.0	23.0	7.55	9.5	333	
	2.0	22.7	7.4	9.1	333	18
	Mean	23.1	7.5	9.6	333.7	16
BP-12	Surface	20.9	7.2	7.8	289	31
	1.0	19.9	7.03	7.1	289	35
	2.0	19.8	6.97	6.87	289	
	Mean	20.2	7.06	7.3	289	33
BP-18	Surface	24.3	6.8	1.0	349	2.1
	1.0	23.4	6.7	0.3	350	3.4
	2.0	22.9	6.7	0.0	353	
	3.0	22.2	6.6	0.0	360	
	Mean	23.2	6.7	0.3	353	2.8
BP-Goula	Surface	31.3	8.4	8.2	288	31.2
	0.61	30.1	8.1	3.5	293	
	1.22	29.8	8.0	2.5	298	
	Mean	30.4	8.2	4.7	293	
BP-25	Surface	32.6	7.4	7.4	279	34.9
	0.61	31.1	7.3	7.3	283	
	1.37	31.0	7.5	7.5	283	
	Mean	31.6	7.4	7.4	281.7	
MSDEQ LADEQ ARDPCE		32.2 32.2 32.0	6.5 - 9.0 6.0 - 9.0 6.0 - 9.0	5.0 5.0 5.0	1000	 25 150 25

MSDEQ = State of Mississippi Department of Enviromental Quality
LADEQ = State of Louisiana Department of Enviromental Quality
ARDPCE = State of Arkansas Department of Pollution control and Ecology

For temperature, shaded concentrations exceed the MS, LA, and AR criteria.

For DO, shaded concentrations are lower than MS, LA, and AR minimum criteria.

Turbidity criteria = 25 NTU for lakes in LA and AR
Turbidity criteria = 150 NTU for Mississippi River in LA
For turbidity, shaded levels exceed LA and AR criteria for lakes.

Table 17-6
Physicochemical Parameters in Water Sample

Sample	Parameter (mg/l)					
	TKN	TP	OPO4	Sulfate	TSS	TS
BP-9A	.334	.311	.311	42.0	8	220
BP-9B	.305	.227	.227	41.1	6	234
BP-8A	.324	.326	.326	39.2	26	268
BP-8B	.484	.341	.341	39.0	30	254
BP-4A	<.10	.381	.381	41.4	20	228
BP-4B	.336	.377	.377	39.6	26	228
BP-3	.560	.219	.219	42.8	20	218
LPB-1A	1.08	<.02	<.02	3.54	12	136
LPB-1B	.415	.143	.133	3.37	10	134
BP-5	.663	.418	.418	42.1	16	218
BP-7	.155	.120	.066	38.9	10	222
BP-10	.211	.309	.309	42.0	20	226
BP-6	.420	.124	.124	36.5	12	182
BP-1	.139	.249	.249	39.6	16	204
BP-2	.264	.097	.097	46.0	22	226
BP-12A	.122	.078	.078	39.7	20	220
BP-12B	.213	.310	.310	39.5	24	222
BP-18	.378	.354	.354	42.7	10	228
MWLBP	.377	.244	.241	63.61	17.11	214.9
MWOLBP	.327	.265	.262	40.76	17.88	224.9
MSDEQ	1.0	0.3				

TKN = Total Kjeldahl Nitrogen in mg/l N
TP = Total Phosphorus in mg/l P
OPO4 = Orthophosphate
TSS = Total Suspended Solids
TS = Total Solids

MWLBP = mean of all samples including those samples collected in LBP-1
MWOLBP = mean of all samples excluding those samples collected in LBP-1

MSDEQ = State of Mississippi Department of Environmental Quality benchmark level

Shaded concentrations exceed MS DEQ benchmark levels.

Table 17-7
Metals in Water Samples

Sample	Metal (ug/l)								
	As	Cr	Cu	Pb	Ni	Zn	Ba	Fe	Mn
BP-9A	<2	<2	1.6	<1	1.6	<10	54	293	32
BP-9B	<2	2	2.5	<1	1.7	<10	55	229	31
BP-8A	<2	<2	1.9	1.1	2.2	<7	60	538	56
BP-8B	<2	2	2	1.3	2.6	<7	61	573	57
BP-4	<2	<2	2	<1	2.2	<7	64	628	65
BP-3	<2	<2	<2	<1	1.5	<7	64	367	84
LBP-1A	5.5	<2	1.6	<1	1.9	<10	86	265	132
LBP-1B	4.3	2	2.7	<1	1.8	<10	81	169	86
BP-5	<2	<2	2	2.3	4	9	73	1200	199
BP-7	<2	<1	1.4	<1	1.3	<10	53	120	20
BP-10	<2	<2	2	<1	1.9	<7	58	441	39
BP-6	2.7	<2	<2	<1	<1	<7	65	214	185
BP-1	<2	<2	<2	<1	1.5	<7	53	267	52
BP-2	<2	<2	3	<1	1.8	<7	61	252	52
BP-12	<2	<2	<2	1.2	1.6	<7	57	348	49
BP-18	2.4	<2	<2	<1	1.2	<7	61	64	364
MeanD	3.7	2	2.1	1.5	1.9	8	62.9	373.0	93.9
MeanA	1.7	0.8	1.7	0.7	1.9	4.5	59.9	395.3	91.8
Detection Limit	2	2	2	1	1	7			
FWA FWC	360 190	2287 273	24.6 15.8	125 4.9	2382 123	156 141		1000	

As = Arsenic
Pb = Lead
Ba = Barium
Cr = Chromium
Ni = Nickel
Fe = Iron
Cu = Copper
Zn = Zinc
Mn = Manganese

Cadmium (detection limit = 0.2 ug/l) , Mercury (detection limit = 0.2 ug/l), Selenium (detection llimit = 2 ug/l), and Cobalt (detection limit = 9 ug/l) were also analyzed but none were detected in any of the samples.

MeanD = mean of detections only
MeanA = mean of all samples using non-detected values at .5 the detection limit

FWA = EPA fresh water acute criteria
FWC = EPA fresh water chronic criteria

Shaded concentrations exceed EPA national criteria.

TABLE 17-8
Surface Sediment Data

1996 Sediment Data - Vicksburg District				
Sample	Parameter (mg/kg)			
	TKN	TP	Sulfate	TOC
BP-9A	116	647	99.7	11,200
BP-9B	127	801	101	16,800
BP-8A	344	556	116	11,000
BP-8B	286	498	80.2	12,200
BP-4A	155	434	20.1	12,900
BP-4B	177	600	17.3	9,440
BP-3	76.3	532	39.6	17,300
LBP-1A	59.7	129	88.8	9,890
LBP-1B	80.1	169	84.4	9,960
BP-5	214	665	39.1	16,900
BP-7	131	662	196	27,700
BP-10	204	610	20.3	12,900
BP-6	121	386	87	4,010
BP-1	329	478	104	7,260
BP-2	82.1	409	77.5	4,670
BP-12A	222	336	200	5,510
BP-12B	66	509	103	5,230
BP-18	258	390	114	8,260
Mean	169.3	489.5	85.1	10,852

TKN = Total Kjeldahl Nitrogen in mg/kg N
TP = Total Phosphorus in mg/kg P
TOC = Total Organic Carbon

TABLE 17-8 (Cont)
Surface Sediment Data

Sample	TKN	TP	TOC	%FINES
1997 Sediment Data - Memphis District				
	Parameter (mg/kg)			
	TKN	**TP**	**TOC**	**%FINES**
Island No. 8	5.66	34.3	56.2	
Chisholm	27.8	522	10,200	
BP-17	<12.4	93.5	8,300	95.9
Brandywine	<10.8	151	12,400	
Tunica	<11.4	100	14,600	
BP-15	<7.20	96.2	6,380	94.2
BP-13	<8.25	104	10,800	60.9
1997 Sediment Data - Vicksburg District				
BP-8	78.8	581	8,110	71.4
Lake Whittington	<10.3	161	16,400	99.7
LPit 1	92.1	568	9,060	99.3
LPit 2	33.3	442	5,550	98.1
LPit 3	29.2	483	3,470	98.1
LPit 4	29.3	296	1,220	58.1
BP-1	75.9	433	9,050	95.1
Palmyra	269	325	1,870	
Yucatan	<14.5	217	17,800	99.2
BP-18	<9.68	90.2	7,170	96.1
Lake Mary	201	630	19,800	92.5
1997 Sediment Data - New Orleans District				
Raccourci	<14.7	71.6	13,000	99.6
Bayou Goula	95.1	579	8,790	
BP-25	137	773	9,500	

TKN = Total Kjeldahl Nitrogen in mg/kg N   TP = Total Phosphorus in mg/kg P
TOC = Total Organic Carbon

Table 17-9
Trace Metal Concentrations in Sediment

Metal	Detections Observations	Mean Minimum Maximum	Earth's Crust Bowen Mean Minimum Maximum	Earth's Crust USGS Mean Minimum Maximum	ER-L ER-M
Arsenic	40 40	6.45 1.4 13.8	6.0 1.0 40	7.4 <0.1 73	8.2 70
Cadmium	39 40	0.91 0.14 4.2	.06 .01 .7		1.2 9.6
Chromium	40 40	19.37 2.6 30.3	100 5 3000	52 1 1000	81 370
Copper	40 40	19.9 0.6 31.5	20 2 100	22 <1 700	34 270
Lead	40 40	23.9 2.6 134.	10 2 200	17 <10 300	46.7 218
Nickel	40 40	23.55 4.3 32.6	40 10 1000	18 <5 700	20.9 51.6
Mercury	38 40	0.21 0.02 0.97	0.03 0.01 0.3	0.12 0.01 3.4	0.15 0.71
Selenium	38 40	0.82 0.29 1.4		0.45 <0.1 3.9	
Zinc	40 40	75.45 8.8 123.	50 10 300	52 <5 2900	150 410
Barium	18 18	190.1 132 239		420 10 1500	
Cobalt	18 18	10.65 7.3 16.4		9.2 <0.3 70	
Iron	18 18	23,483 15,000 28,300	38,000	25,000 100 >100,000	
Manganese	18 18	684.5 369 1030		640 <2 7000	

Detections = number of samples with detectable concentrations
Observations = total number of samples collected

The concentrations for metals in the earth's crust determined by the USGS are for the eastern United States (east of the 96th meridian).

Table 17-10
Dates for Water, Sediment, and Fish Tissue Sampling and Analysis

Sample	Water			Sediment			Fish Tissue		
	Metals	Pesticides	Other PP	Metals	Pesticides	Other PP	Metals	Pesticides	Other PP
	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed
Island No. 8				12 Sep 97 17 Oct 97	12 Sep 97 20 Nov 97	12 Sep 97 29 Sep 97 & 16 Oct 97	12 Sep 97 14 Nov 97	12 Sep 97 10 Dec 97	12 Sep 97 26 Sep 97
Chisholm				12 Sep 97 17 Oct 97			12 Sep 97 14 Nov 97	12Sep 97 08 Apr 98	12 Sep 97 11 Mar 98
BP-17				11 Aug 97 01 Dec 97			11 Aug 97 18 Sep 97		
							29 Aug 97 9 Dec 97		
Brandywine				12 Sep 97 17 Oct 97			12 Sep 97 14 Nov 97		
Tunica				08 Sep 97 02 Dec 97			08 Sep 97 12 Nov 97		
BP-15				04 Aug 97 10 Dec 97			04 Aug 97 15 Aug 97		
BP-13				04 Aug 97 10 Dec 97	04 Aug 97 18 Sep 97	04 Aug 97 21 Aug 97 & 25 Nov 97	27 Aug 97 23 Sep 97	27 Aug 97 10 Dec 97	27 Aug 97 02 Oct 97
BP-9	20 May 96 19 Sep 96	20 May 96 28 Jun 96		20 May 96 11 Sep 96	20 May 96 27 Jun 96				
BP-8	20 May 96 28 Jun 96	20 May 96 28 Jun 96	20 May 96 10 Jun 96 & 11 Jun 96	20 May 96 28 Jun 96	20 May 96 27 Jun 96	20 May 96 15 Jul 96	26 Sep 97 08 Dec 97		
				26 Sep 97 12 Dec 97					
Whittington							28 Jul 97 6 Aug 97		
							29 Aug 97 9 Dec 97		
							12 Sep 97 14 Nov 97		

Table 17-10 (cont)
Dates for Water, Sediment, and Fish Tissue Sampling and Analysis

Sample	Water			Sediment			Fish Tissue		
	Metals	Pesticides	Other PP	Metals	Pesticides	Other PP	Metals	Pesticides	Other PP
	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed
LPit-2				18 Sep 97 12 Dec 97	18 Sep 97 21 Nov 97	18 Sep 97 01 Dec 97	22 Sep 97 25 Nov 97	22 Sep 97 10 Dec 97	
LPit-3				18 Sep 97 12 Dec 97	18 Sep 97 21 Nov 97	18 Sep 97 01 Dec 97	22 Sep 97 25 Nov 97	22 Sep 97 10 Dec 97	
LPit-4				18 Sep 97 12 Dec 97	18 Sep 97 21 Nov 97	18 Sep 97 01 Dec 97	22 Sep 97 25 Nov 97	22 Sep 97 10 Dec 97	
BP-4	15 May 96 20 Sep 96	15 May 96 21 Jun 96	17 May 96 10 Jun 96	15 May 96 17 Sep 96	15 May 96 26 Jun 96	17 May 96 16 Jul 96			
BP-3	15 May 96 20 Sep 96	15 May 96 21 Jun 96		15 May 96 17 Sep 96	15 May 96 26 Jun 96				
LBP-1	24 May 96 28 Jun 96	24 May 96 26 Jun 96	24 May 96 10 Jun 96 & 05 Jul 96	24 May 96 28 Jun 96 & 13 Sep 96	24 May 96 18 Jul 96	24 May 96 03 Jul 96 & 16 Jul 96	11 Dec 97 29 May 98	11 Dec 97 09 Feb 98	
BP-5	15 May 96 20 Sep 96	15 May 96 21 Jun 96		15 May 96 17 Sep 96	15 May 96 26 Jun 96				
BP-7	21 May 96 28 Jun 96	21 May 96 26 Jun 96	21 May 96 10 Jun 96	21 May 96 28 Jun 96	21 May 96 27 Jun 96	21 May 96 28 Jun 96 & 03 Jul 96			
BP-10	15 May 96 20 Sep 96	15 May 96 21 Jun 96		15 May 96 17 Sep 96	15 May 96 26 Jun 96				
BP-6	17 May 96 19 Sep 96	17 May 96 21 Jun 96		17 May 96 13 Sep 96	17 May 96 26 Jun 96				
BP-1	17 May 96 19 Sep 96	17 May 96 21 Jun 96		17 May 96 13 Sep 96	17 May 96 26 Jun 96		26 Sep 97 10 Dec 97	26 Sep 97 10 Dec 97	26 Sep 97 31 Oct 97
				22 Sep 97 12 Dec 97					
Palmyra				13 Jun 97 18 Aug 97	13 Jun 97 15 Aug 97	13 Jun 97 07 Jul 97 & 22 Aug 97	29 Aug 97 31 Oct 97	29 Aug 97 10 Dec 97	29 Aug 97 22 Sep 97
Yucatan				27 Aug 97 03 Oct 97	27 Aug 97 17 Sep 97	27 Aug 97 29 Sep 97 & 16 Oct 97	29 Aug 97 31 Oct 97	29 Aug 97 10 Dec 97	29 Aug 97 22 Sep 97

Table 17-10 (cont)
Dates for Water, Sediment, and Fish Tissue Sampling and Analysis

Sample	Water			Sediment			Fish Tissue		
	Metals	Pesticides	Other PP	Metals	Pesticides	Other PP	Metals	Pesticides	Other PP
	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed	Delivered Analyzed
BP-18	17 May 96 19 Sep 96	17 May 96 21 Jun 96		17 May 96 13 Sep 96	17 May 96 26 Jun 96		29 Aug 97 09 Dec 97		
				29 Aug 97 01 Dec 97			22 Sep 97 25 Nov 97		
Lake Mary				22 Sep 97 12 Dec 97	22 Sep 97 21 Nov 97	22 Sep 97 24 Oct 97 & 01 Dec 97	22 Sep 97 25 Nov 97		
Raccourci				29 Aug 97 01 Dec 97	29 Aug 97 03 Oct 97	29 Aug 97 29 Sep 97 & 16 Oct 97	29 Aug 97 09 Dec 97	29 Aug 97 10 Dec 97	29 Aug 97 20 Nov 97
Goula				18 Aug 97 26 Sep 97	18 Aug 97 17 Sep 97	18 Aug 97 29 Sep 97 & 16 Oct 97	18 Aug 97 08 Oct 97	18 Aug 97 10 Dec 97	18 Aug 97 10 Dec 97
BP-25				18 Aug 97 26 Sep 97			25 Aug 97 06 Oct 97		
							29 Aug 97 31 Oct 97		

Delivered = Date water, sediment, and fish tissue samples were delivered to the U.S. Army Corps of Engineers, Waterways Experimental Station, Environmental Laboratory, Analytical Laboratory Group for analysis. After collection, all samples were stored in individual containers in ice chests until delivered to the WES lab. All samples were delivered within 1 to 6 days after they were collected.

Analyzed = Date samples were analyzed.

Table 17-11
Length and Weight of Analyzed Fish

Sampling Location	Species	Length (cm)	Weight (kg)	Analyzed for Metals	Analyzed for Pesticides
Island No. 8	Channel Cat	48.0	1.043	X	X
	Channel Cat	57.9	1.361	X	X
	SM Buffalo	40.0	1.134	X	X
Chisholm	Channel Cat	45.0	0.820	X	X
	Channel Cat	37.5	0.480	X	X
	BM Buffalo	52.0	2.199	X	X
	BM Buffalo	40.5	1.012	X	X
	Black Crappie	30.5	0.520	X	X
	Black Crappie	31.0	0.560	X	X
BP-17	LM Bass	31.0	0.480	X	
	LM Bass	29.4	0.360	X	
	LM Bass	26.0	0.254	X	
	LM Bass	30.0	0.375	X	
	LM Bass	30.0	0.375	X	
	LM Bass	45.0	1.229	X	
	Bluegill	19.6	0.158	X	
		20.0	0.160	X	
		19.4	0.168	X	
		16.5	0.110	X	
		15.8	0.100	X	
		16.0	0.104	X	
		16.2	0.100	X	
	Black Buffalo	36.0	0.500	X	
	Black Buffalo	33.0	0.620	X	
	Black Buffalo	34.0	0.930	X	
	Black Buffalo	29.5	0.430	X	
Brandywine	Channel Cat	54.0	1.077	X	
	Channel Cat	47.0	0.907	X	
	Black Buffalo	60.0	3.221	X	
	Black Buffalo	55.0	2.608	X	
	White Crappie	34.0	0.690	X	
	White Crappie	27.0	0.300	X	
	LM Bass	48.0	1.656	X	
	LM Bass	25.0	0.240	X	
Tunica	BM Buffalo	49.0	1.996	X	
	BM Buffalo	53.0	2.585	X	
	Channel Cat	58.0	2.472	X	
	Channel Cat	57.0	1.814	X	
	Black Crappie	25.0	0.280	X	
		26.0	0.240	X	
	LM Bass	37.0	1.000	X	
	LM Bass	40.0	0.890	X	

Table 17-11 (cont)
Length and Weight of Analyzed Fish

Sampling Location	Species	Length (cm)	Weight (kg)	Analyzed for Metals	Analyzed for Pesticides
BP-15	White Crappie	29.2	0.315	X	
	White Crappie	25.0	0.310	X	
	LM Bass	40.0	1.066	X	
	LM Bass	49.0	2.064	X	
	Black Crappie	26.2	0.320	X	
	Black Crappie	27.4	0.325	X	
	BM Buffalo	40.5	2.454	X	
	BM Buffalo	57.0	4.309	X	
	Flathead Cat		1.564	X	
BP-13	BM Buffalo	58.0	4.314	X	X
	BM Buffalo	52.0	2.722	X	X
	White Crappie	23.5	0.220	X	X
	White Crappie	22.0	0.222	X	X
	Channel Cat	57.0		X	X
BP-8	White Crappie	22.5	0.220	X	
	Channel Cat	58.0	1.424	X	
	Channel Cat	56.0	2.268	X	
	Black Buffalo	45.0	1.588	X	
	Black Buffalo	47.0	1.361	X	
Whittington	BM Buffalo	63.0	7.394	X	
	BM Buffalo	58.0	3.317	X	
	BM Buffalo	72.0	9.344	X	
	Black Buffalo	66.0	4.990	X	
	Black Buffalo	58.0	3.175	X	
	SM Buffalo	58.0	2.268	X	
	SM Buffalo	47.5	2.268	X	
	Blue Catfish	48.1	1.276	X	
	Blue Catfish	41.0	0.907	X	
	Black Crappie	24.5 23.5	0.230 0.210	X X	
	Black Crappie	32.0	0.52	X	
LPit 2	LM Bass	37.0	0.630	X	X
	Black Crappie	27.5 22.0 22.0	0.360 0.170 0.180	X X X	X X X
	Channel Cat	54.0	1.814	X	X
	Channel Cat	59.0	2.892	X	X
	BM Buffalo	49.0	2.268	X	X
	BM Buffalo	52.0	2.419	X	X
LPit 3	LM Bass	36.0	0.776	X	X
LPit 4	Channel Cat	46.0	0.907	X	X
	Channel Cat	38.0	0.510	X	X
	BM Buffalo	56.0	2.332	X	X
	BM Buffalo	53.0	1.814	X	X

Table 17-11 (cont)
Length and Weight of Analyzed Fish

Sampling Location	Species	Length (cm)	Weight (kg)	Analyzed for Metals	Analyzed for Pesticides
LBP-1	BM Buffalo	52.5	2.585	X	X
	BM Buffalo	65.0	5.352	X	X
	LM Bass	33.8	0.620	X	X
		35.8	0.830	X	X
		34.0	0.640	X	X
	Channel Cat	45.0	0.690	X	X
		49.0	0.920	X	X
		39.0	0.450	X	X
	White Crappie	23.3	0.150	X	X
		24.0	0.170	X	X
BP-1	White Crappie	37.0	0.750	X	X
	White Crappie	27.5	0.350	X	X
		26.0	0.290	X	X
	LM Bass	52.0	1.814	X	X
	Channel Cat	60.0	1.878	X	X
	Channel Cat	50.0	1.446	X	X
	Black Buffalo	57.5	2.864	X	X
	Black Buffalo	49.0	1.814	X	X
Palmyra	Flathead Cat	46.0	0.800	X	X
	Channel Cat	59.0	1.859	X	X
	Channel Cat	50.0		X	X
	BM Buffalo	47.0	1.814	X	X
	BM Buffalo	51.0	1.588	X	X
Yucatan	BM Buffalo	58.0	3.402	X	X
	Black Crappie	27.2	0.350	X	X
	Black Crappie	26.0	0.280	X	X
	Channel Cat	36.0	0.400	X	X
	Channel Cat	47.0	0.970	X	X
BP-18	White Crappie	34.0	0.550	X	
	White Crappie	37.0	0.730	X	
	Channel Cat	61.0	2.467	X	
	Channel Cat	64.0	1.446	X	
	Black Buffalo	55.0	2.631	X	
	Black Buffalo	42.6	1.200	X	
	LM Bass	38.0	0.950	X	
Lake Mary	White Crappie	25.5	0.220	X	
	Black Crappie	28.0	0.370	X	
	Channel Cat	52.0	1.361	X	
	LM Bass	46.0	1.361	X	
	LM Bass	39.0	0.780	X	
	Black Buffalo	68.5	4.082	X	
	Black Buffalo	54.0	2.332	X	
Raccourci	Channel Cat	54.0	1.760	X	X
	SM Buffalo	47.0	1.909	X	X
	SM Buffalo	42.0	1.292	X	X
	LM Bass	37.0	0.765	X	X

Table 17-11 (cont)
Length and Weight of Analyzed Fish

Sampling Location	Species	Length (cm)	Weight (kg)	Analyzed for Metals	Analyzed for Pesticides
Goula	White Crappie	31.0	0.470	X	X
	White Crappie	37.0	0.745	X	X
	LM Bass	51.9	2.223	X	X
	LM Bass	33.0	0.580	X	X
	Channel Cat	37.6	0.492	X	X
	Channel Cat	41.1	0.684	X	X
	BM Buffalo	50.4	2.676	X	X
	BM Buffalo	62.2	3.901	X	X
BP-25	White Crappie	34.8	0.550	X	
	White Crappie	29.9	0.300	X	
	White Crappie	26.0	0.240	X	
	White Crappie	27.0	0.280	X	
	LM Bass	43.6	1.361	X	
	BM Buffalo	54.6	2.812	X	
	BM Buffalo	51.5	2.359	X	
	Channel Cat	44.7	0.880	X	
	Channel Cat	42.2	0.718	X	

Each blocked row within the table represents one analysis. Some blocks include more than one fish. In those instances, the individual fish were too small to provide a sufficient amount of tissue for the required analysis. Therefore, composites of two or more fish of the same species were used. The block for bluegill in BP-17 includes 7 fish. These fish were grouped into 2 composites for analysis.

Table 17-12
Observed Fish Tissue Pesticide Levels

	Mean Pesticide Level (mg/kg) Number of Detections / Number of Observations										
Pesticide	All Fish	River Fish	Land Fish	BMB	SMB	Blk Buff	Blk Crp	Wht Crp	LMB	Chn Cat	Flat Cat
B-BHC	0.003 2/58	0.003 2/40	0/18	0/14	0.003 2/3	0/2	0/3	0/7	0/8	0/19	0/2
DDD	0.034 21/58	0.011 7/40	0.045 14/18	0.062 7/14	0.013 1/3	0/2	0/3	0/7	0.007 2/8	0.023 11/19	0/2
DDE	0.334 35/58	0.027 18/40	0.659 17/18	0.778 9/14	0.009 2/3	0.013 1/2	0.007 1/3	0.019 2/7	0.447 3/8	0.193 17/19	0/2
DDT	0.033 27/58	0.008 11/40	0.049 16/18	0.064 9/14	0/3	0.012 2/2	0.014 1/3	0.006 1/7	0.011 3/8	0.021 11/19	0/2
Dieldrin	0.009 11/58	0.006 04/40	0.010 7/18	0.011 5/14	0.003 1/3	0/2	0/3	0/7	0/8	0.008 5/19	0/2
Endosulfan I	0.005 4/58	0/40	0.005 4/18	0.005 4/14	0/3	0/2	0/3	0/7	0/8	0/19	0/2
Endosulfan II	0.019 1/58	0/40	0.019 1/18	0.019 1/14	0/3	0/2	0/3	0/7	0/8	0/19	0/2
Endosulfan Sulfate	0.011 2/58	0/40	0.011 2/18	0.011 2/14	0/3	0/2	0/3	0/7	0/8	0/19	0/2
Endrin	0.045 3/58	0.002 1/40	0.067 2/18	0.067 2/14	0/3	0/2	0/3	0/7	0/8	0/19	0.002 1/2
Heptachlor Epoxide	0.003 1/58	0.003 1/40	0/18	0/14	0/3	0/2	0/3	0/7	0/8	0.003 1/19	0/2
Methoxychlor	0.018 3/58	0.018 3/40	0/18	0.015 2/14	0/3	0.024 1/2	0/3	0/7	0/8	0/19	0/2
PCB 1260	0.071 9/58	0.071 9/40	0/18	0.062 2/14	0.061 1/3	0/2	0/3	0/7	0/8	0.076 6/19	0/2

All Fish = all sampled fish
River Fish = all fish collected from riverside of the levee
Land Fish = all fish collected from landside of the levee
BMB = Big Mouth Buffalo
SMB = Small Mouth Buffalo
Blk Buff = Black Buffalo
Blk Crp = Black Crappie
Wht Crp = White Crappie
LMB = Large Mouth Bass
Chn Cat = Channel Catfish
Flat Cat = Flathead Catfish

TABLE 17-13
FISH TISSUE PESTICIDE LEVELS BY LOCATION

Sampling Location	Species	Weight (kg)	Pesticide (mg/kg)					
			DDD	DDE	DDT	tDDT	Dieldrin	PCB 1260
Island No 8	Channel Cat	1.04	0.019	0.009	0.009	0.037	0.011	0.077
Island No 8	Channel Cat	1.36	<	0.010	0.007	0.017	0.005	0.031
Island No 8	SM Buffalo	1.13	<	0.005	<	0.005	0.003	0.061
BP-13	White Crappie	0.22	<	<	<		<	<
BP-13	White Crappie	0.22	<	<	<		<	<
BP-13	Channel Cat		0.007 0.001	0.104 0.125	0.011 0.011	0.122 0.137	< <	< <
BP-13	BM Buffalo	2.72	0.014	0.045	0.008	0.067	<	<
BP-13	BM Buffalo	4.31	<	0.016	0.004	0.020	<	<
BP-1	Black Buffalo	2.86	<	<	0.006	.006	<	<
BP-1	Black Buffalo	1.81	<	0.013	0.018	.031	<	<
BP-1	Channel Cat	1.88	<	0.005	<	.005	<	<
BP-1	Channel Cat	1.45	<	0.039	<	.039	<	0.049
BP-1	White Crappie	0.75	<	<	<		<	<
BP-1	White Crappie	0.64 C	<	<	<		<	<
BP-1	LM Bass	1.81	<	<	<		<	<
Palmyra	Channel Cat		<	0.053	0.007	.060	<	0.113
Palmyra	Channel Cat	1.86	0.009	0.009	<	.018	0.005	<
Palmyra	Flathead Cat	0.80	< <	< <	< <		< <	< <
Palmyra	BM Buffalo	1.59	<	<	<		<	<
Palmyra	BM Buffalo	1.81	<	<	<		<	<
Yucatan	Channel Cat	0.40	<	<	<		<	<
Yucatan	Channel Cat	0.97	<	0.015	<	0.015	<	<
Yucatan	Black Crappie	0.35	<	<	<		<	<

TABLE 17-13 (Cont)
FISH TISSUE PESTICIDE LEVELS BY LOCATION

Sampling Location	Species	Weight (kg)	Pesticide (mg/kg)					
			DDD	DDE	DDT	tDDT	Dieldrin	PCB 1260
Yucatan	Black Crappie	0.28	<	<	<		<	<
Yucatan	BM Buffalo	3.40	< <	< <	< <		< <	< <
Raccourci	Channel Cat	1.76	<	<	<		<	<
Raccourci	SM Buffalo	1.91	<	<	<		<	<
Raccourci	SM Buffalo	1.29	0.013	0.012	<	0.025	<	<
Raccourci	LM Bass	0.77	<	<	<		<	<
Goula	BM Buffalo	2.68	<	<	<		<	0.046
Goula	BM Buffalo	3.90	<	0.009	0.006	0.015	<	0.077
Goula	Channel Cat	0.49	0.006	0.009	<	0.015	<	0.120
Goula	Channel Cat	0.68	<	0.005	<	0.005	<	0.065
Goula	LM Bass	2.22	<	<	<		<	<
Goula	LM Bass	0.58	<	<	<		<	<
Goula	White Crappie	0.47	<	0.001	0.006	.007	<	<
Goula	White Crappie	0.75	<	<	<		<	<
LPit-2	BM Buffalo	2.27	0.022	0.209	0.062	0.293	0.008	<
LPit-2	BM Buffalo	2.42	0.041	0.328	0.098	0.467	0.015	<
LPit-2	LM Bass	0.63	<	0.041	0.011	0.052	<	<
LPit-2	Black Crappie	0.71 C	<	0.007	0.014	0.021	<	<
LPit-2	Channel Cat	2.89	0.055	0.502	0.065	0.622	0.008	<
LPit-2	Channel Cat	1.81	0.040	0.199	0.074	0.313	0.011	<
LPit-3	LM Bass	0.78	<	<	<		<	<
LPit-4	BM Buffalo	1.81	0.022	0.367	0.037	0.426	0.012	<
LPit-4	BM Buffalo	2.33	0.053	0.124	0.065	0.242	0.012	<
LPit-4	Channel Cat	0.51	0.008	0.104	0.006	0.118	<	<

TABLE 17-13 (Cont)
FISH TISSUE PESTICIDE LEVELS BY LOCATION

Sampling Location	Species	Weight (kg)	Pesticide (mg/kg)					
			DDD	DDE	DDT	tDDT	Dieldrin	PCB 1260
LPit-4	Channel Cat	0.91	0.008	0.090	0.006	0.104	<	<
LBP-1	LM Bass	2.09 C	0.008 0.006	0.080 1.220	0.016 0.005	0.104 1.231	< <	< <
LBP-1	White Crappie	0.32 C	<	0.036	<	0.036	<	<
LBP-1	BM Buffalo	2.59	0.094	2.102	0.099	2.295	<	<
LBP-1	BM Buffalo	5.35	0.186	3.800	0.199	4.185	0.006	<
LBP-1	Channel Cat	2.06 C	0.030 0.062	0.990 1.010	0.010 0.021	1.030 1.093	< <	< <

Notes:
1. tDDT = total DDT = DDD + DDE + DDT
2. The letter "C" by the weight indicates a composite sample of two or more fish. The weight is the total weight of all the fish used for the composite. The weights of the individual fish are contained in Table 17-10.

TABLE 17-14
Trace Metal Concentrations In Fish Tissue

Fish Sample	Parameter (mg/kg)									
	AS	CD	CR	CU	PB	HG	NI	SE	AG	ZN
Big Mouth Buffalo										
Mean (25)	0.139	0.017	0.266	0.174	0.061	0.206	0.086	0.401	0.218	5.367
Minimum	0.055	0.005	0.067	0.027	0.027	0.024	0.0268	0.134	0.400	2.740
Maximum	0.300	0.134	0.500	0.512	0.199	0.541	0.800	0.600	0.690	13.10
Black Buffalo										
Mean (16)	0.147	0.030	0.176	0.170	0.059	0.123	0.071	0.442	0.282	4.276
Minimum	0.063	0.006	0.067	0.028	0.028	0.043	0.031	0.200	0.046	3.420
Maximum	0.616	0.200	0.425	0.500	0.100	0.423	0.308	0.688	1.090	6.790
Small Mouth Buffalo										
Mean (5)	0.132	0.011	0.139	0.397	0.060	0.077	0.066	0.424	0.484	5.073
Minimum	0.129	0.006	0.067	0.188	0.047	0.068	0.031	0.201	0.047	4.420
Maximum	0.134	0.013	0.282	0.600	0.067	0.082	0.100	0.671	0.804	5.500
Black Crappie										
Mean (15)	0.153	0.013	0.307	0.057	0.044	0.182	0.048	0.526	0.157	5.386
Minimum	0.062	0.006	0.089	0.031	0.027	0.081	0.027	0.387	0.041	3.880
Maximum	0.300	0.040	0.600	0.088	0.067	0.339	0.086	0.687	0.600	8.340
White Crappie										
Mean (21)	0.153	0.011	0.313	0.116	0.052	0.187	0.193	0.414	0.222	6.322
Minimum	0.062	0.005	0.067	0.028	0.027	0.030	0.027	0.297	0.027	3.610
Maximum	0.208	0.013	0.598	0.488	0.100	0.497	2.500	0.597	0.895	11.20
Blue Catfish										
Mean (5)	0.134	0.017	0.100	0.200	0.067	0.106	0.067	0.134	0.501	5.91
Minimum	0.134	0.013	0.100	0.200	0.067	0.065	0.067	0.134	0.500	5.29
Maximum	0.134	0.020	0.100	0.200	0.067	0.146	0.067	0.134	0.502	6.53
Channel Catfish										
Mean (29)	0.102	0.010	0.280	0.117	0.049	0.108	0.045	0.347	0.136	6.717
Minimum	0.054	0.005	0.067	0.027	0.027	0.034	0.027	0.134	0.028	3.540
Maximum	0.134	0.013	0.595	0.399	0.200	0.231	0.100	0.727	0.797	14.60
Flathead Catfish										
Mean (2)	0.125	0.013	0.401	0.143	0.063	0.149	0.063	0.311	0.147	5.993
Minimum	0.120	0.012	0.300	0.067	0.060	0.129	0.060	0.274	0.045	5.520
Maximum	0.134	0.013	0.456	0.182	0.067	0.188	0.067	0.358	0.300	6.900
Bluegill										
Mean (7)	0.134	0.013	0.067	0.200	0.067	0.156	0.067	0.499	0.300	7.740
Minimum	0.134	0.013	0.067	0.199	0.067	0.154	0.067	0.498	0.299	7.080
Maximum	0.134	0.013	0.067	0.200	0.067	0.157	0.067	0.500	0.300	8.400
Largemouth Bass										
Mean (25)	0.126	0.011	0.277	0.092	0.053	0.400	0.051	0.448	0.142	5.770
Minimum	0.013	0.006	0.067	0.028	0.027	0.150	0.027	0.134	0.042	2.140
Maximum	0.300	0.013	0.698	0.201	0.100	0.899	0.067	0.798	0.401	12.20
FWS National Contaminant Study										
Mean	0.16	0.04		0.86	0.19	0.11		0.46		25.63
Minimum	0.04	0.01		0.29	0.10	0.01		0.09		7.69
Maximum	2.08	0.41		38.75	6.73	1.10		3.65		168.1
EPA Safe Value for Human Consumption	3.0	10.0				0.6		50.0		

The number in ( ) after "Mean" represents the number of fish of that species that were sampled.
Metal levels that were less than the detection limit were set equal to two thirds (2/3) of the detection limit.

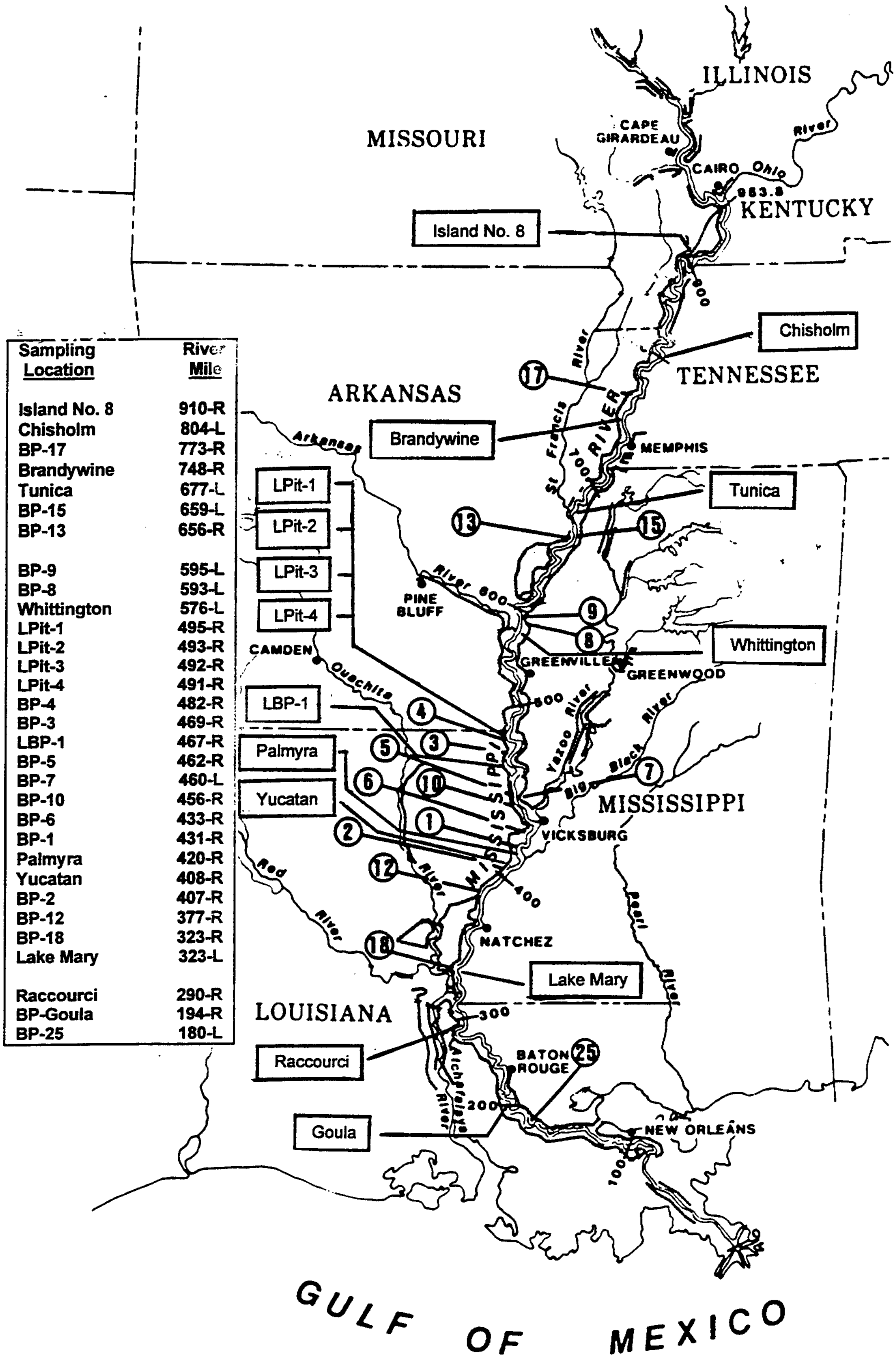


Figure 17-1
Water Quality Sampling Locations

Figure 17-2
ppDDE in Sediment

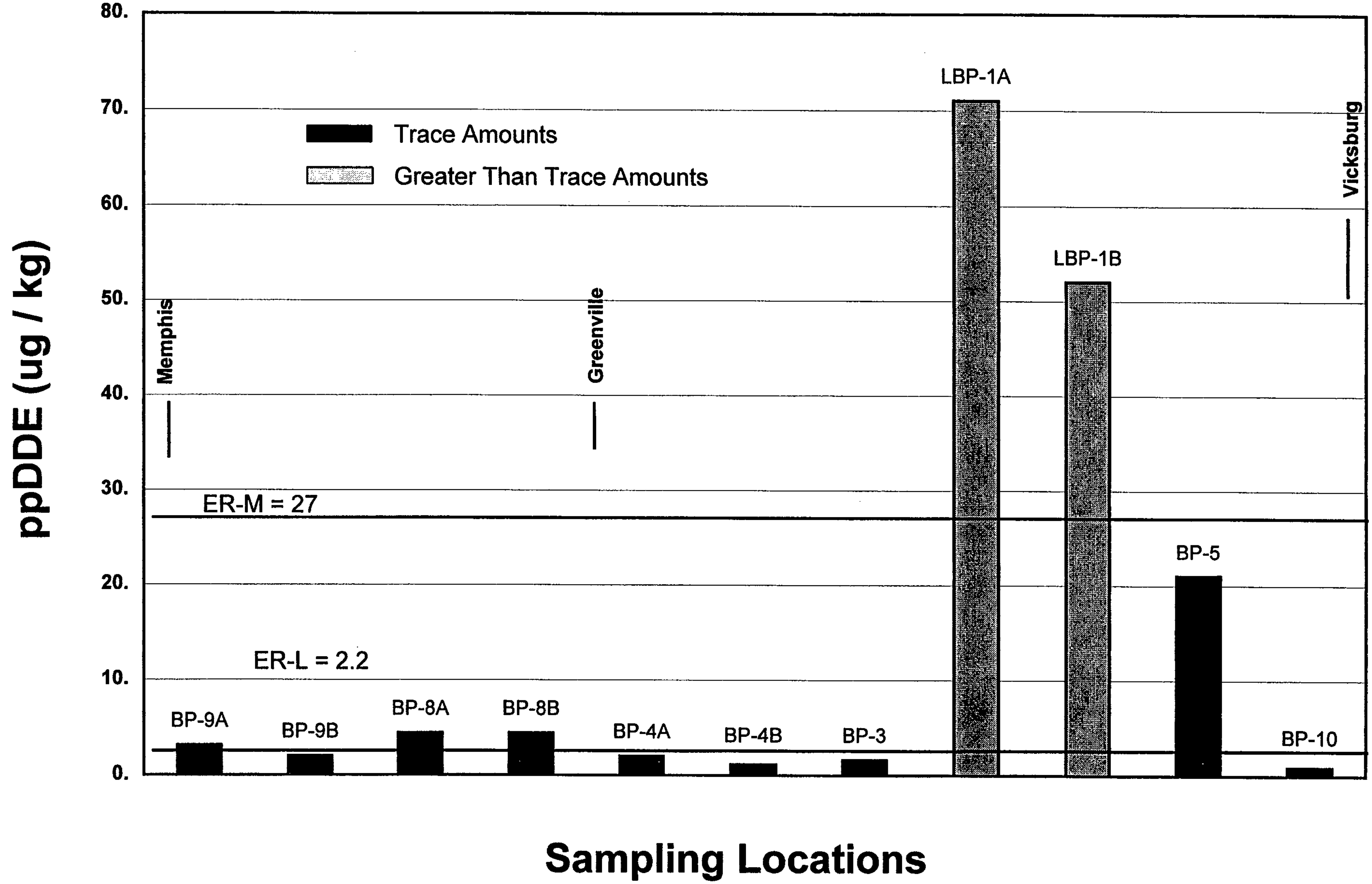
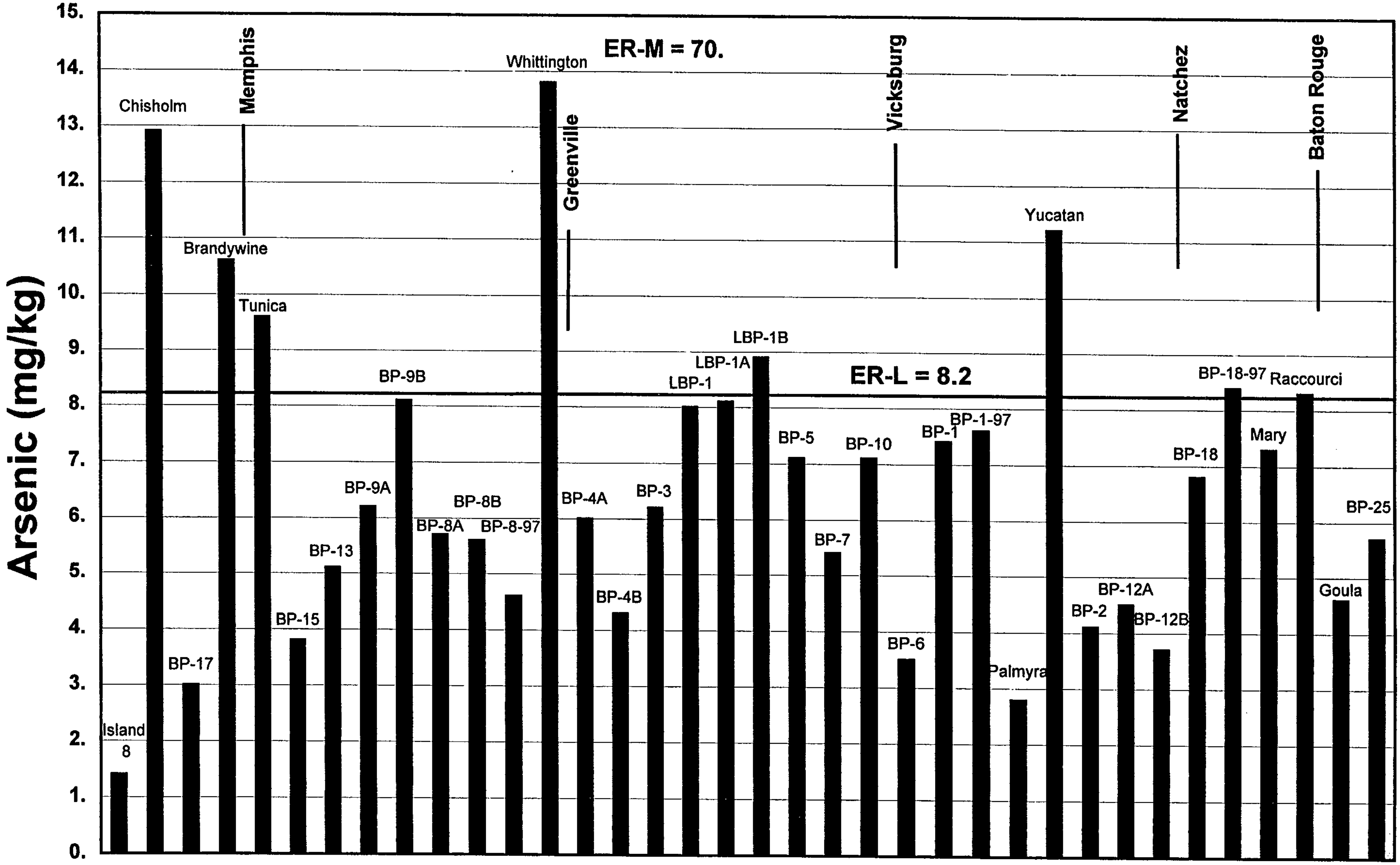


Figure 17-3
Arsenic in Sediment



Sampling Locations

Figure 17-4
Cadmium in Sediment

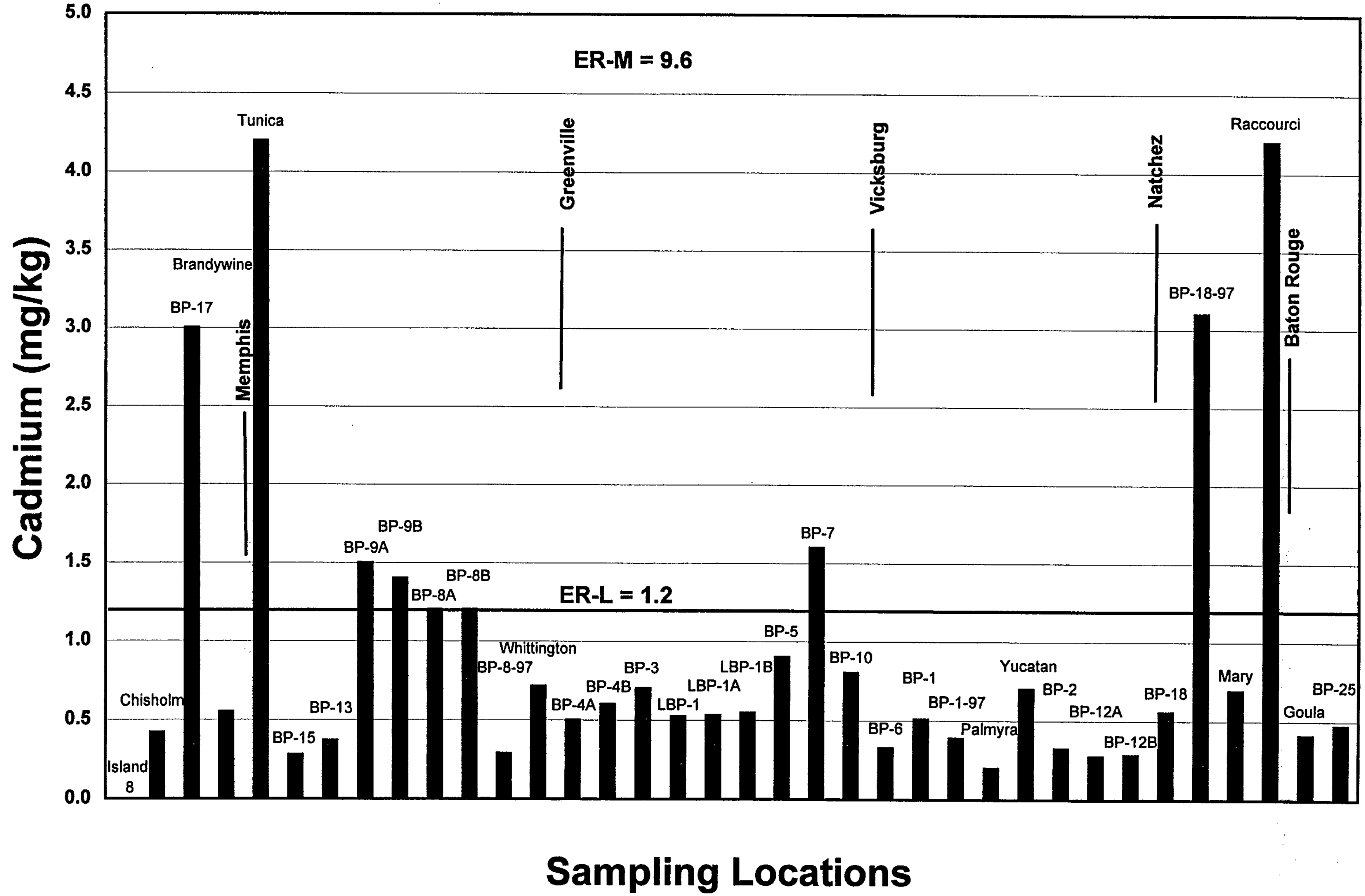


Figure 17-5
Chromium in Sediment

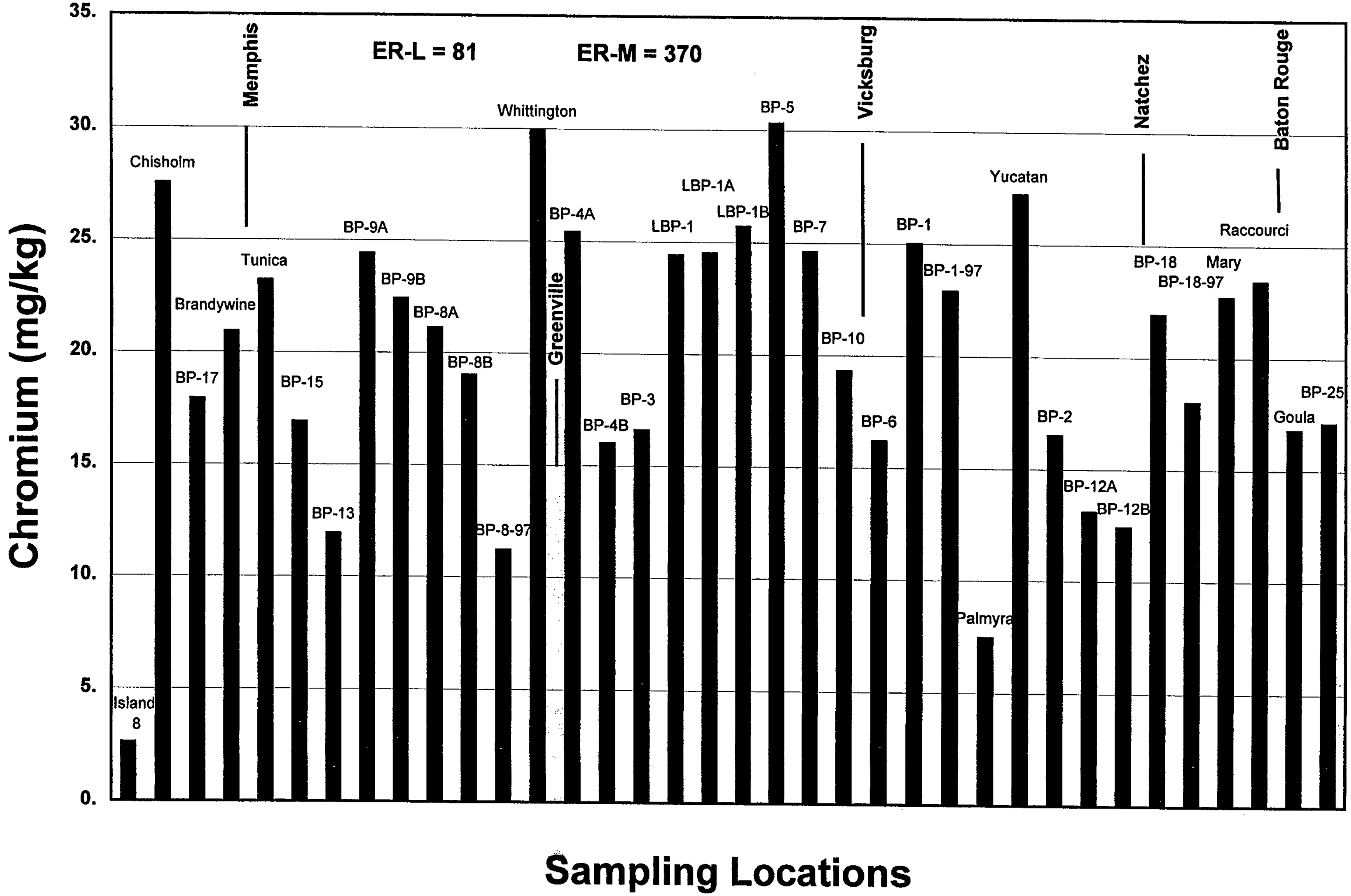


Figure 17-6
Copper in Sediment

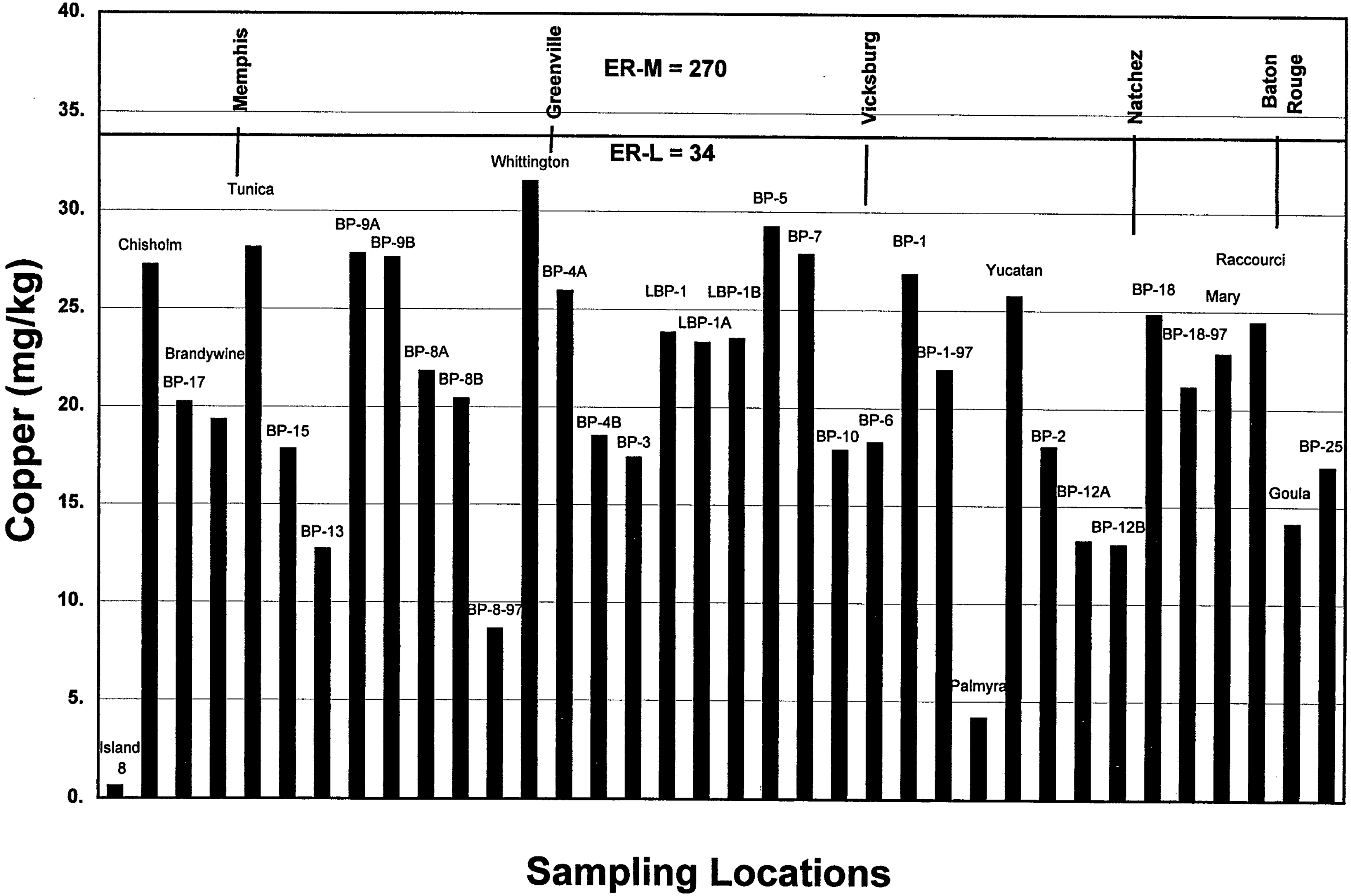


Figure 17-7
Lead in Sediment

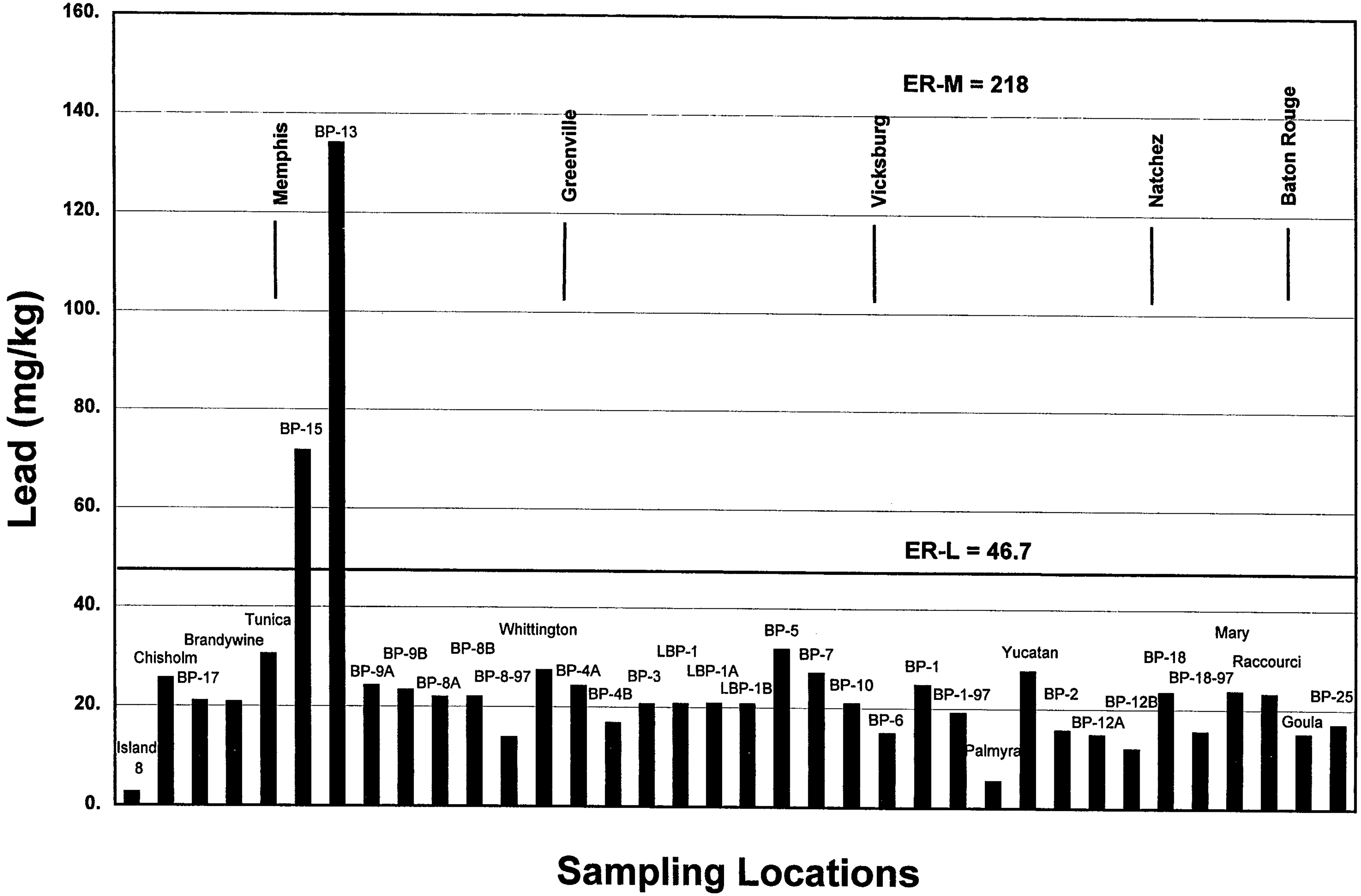


Figure 17-8
Mercury in Sediment

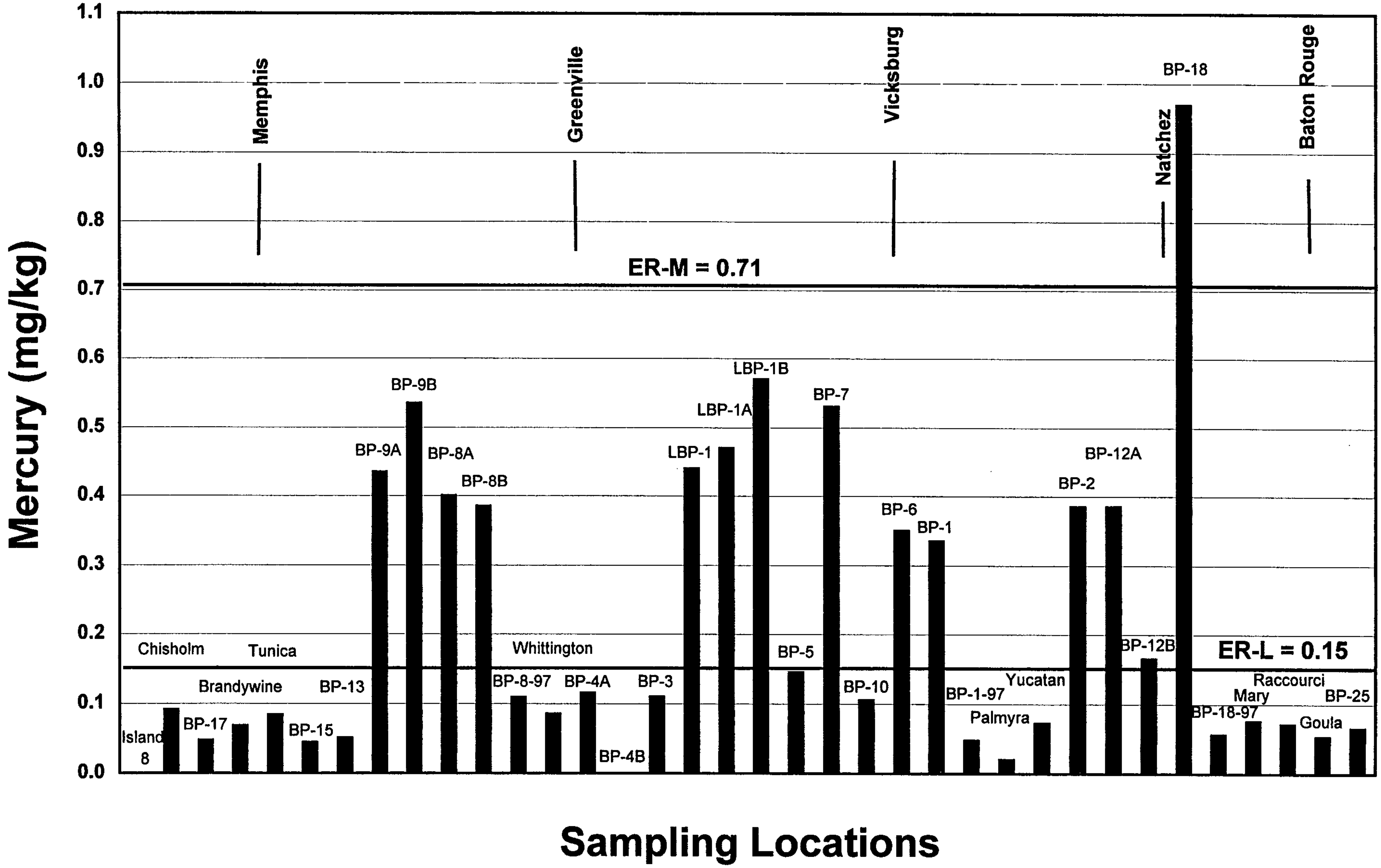


Figure 17-9
Nickel in Sediment

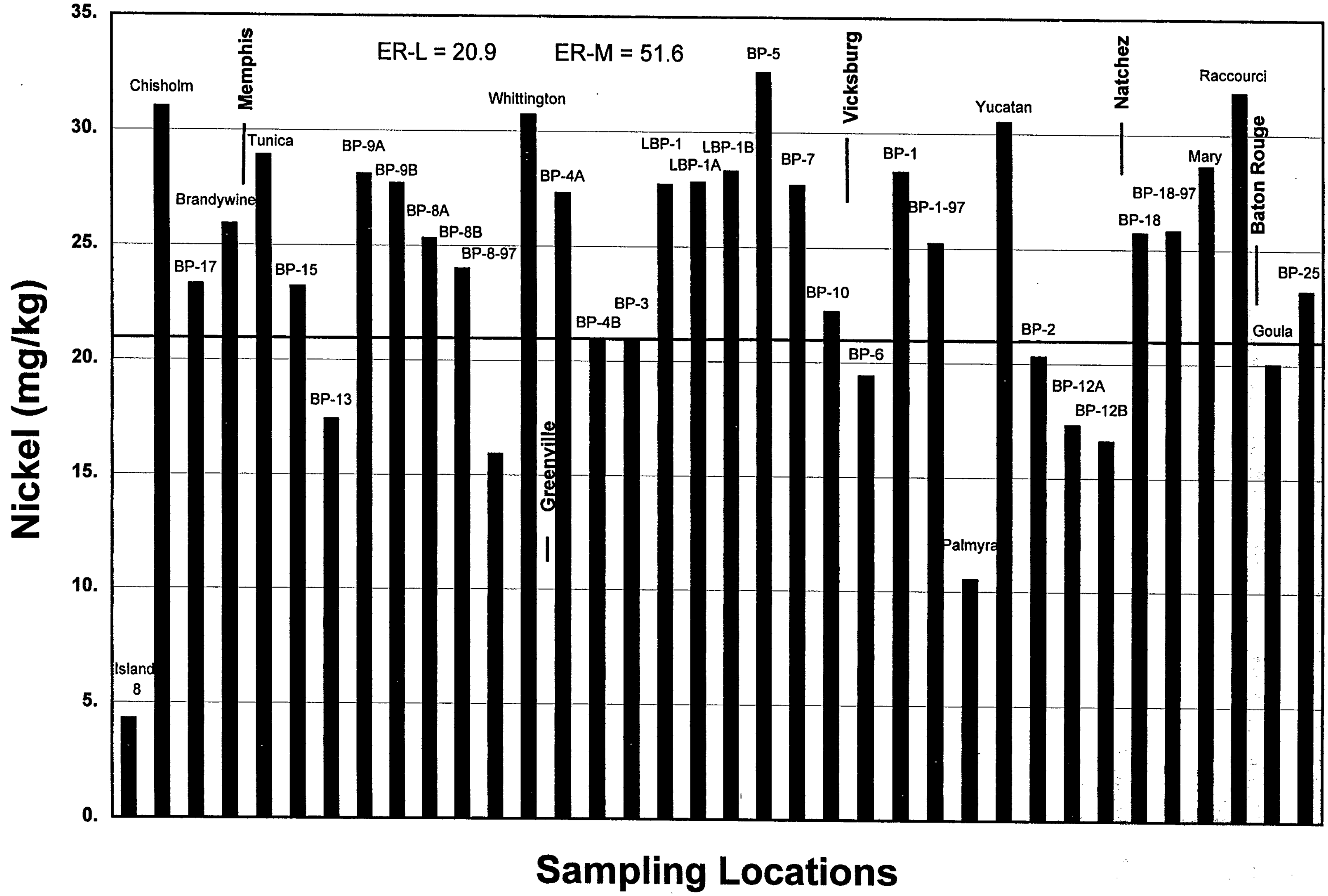


Figure 17-10
Selenium in Sediment

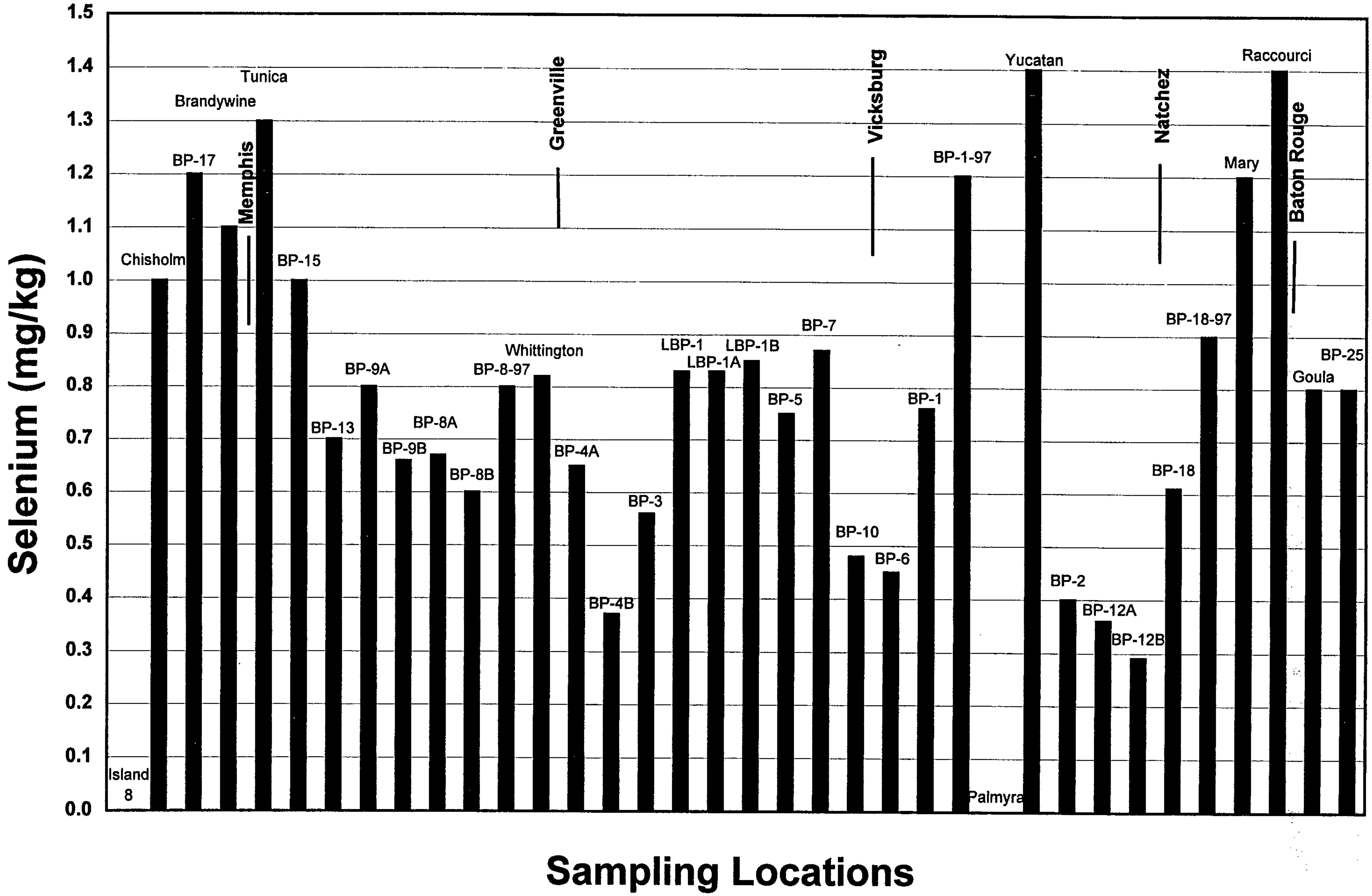


Figure 17-11
Zinc in Sediment